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A TREATISE

ON

AGRICULTURE,

&c. &c.

M. Dowd

A TREATISE

ON

AGRICULTURE,

COMPREHENDING THE

NATURE, PROPERTIES, AND IMPROVEMENT OF SOILS;
THE STRUCTURE, FUNCTIONS, AND CULTIVATION OF PLANTS;
AND THE HUSBANDRY OF THE DOMESTIC
ANIMALS OF THE FARM.

Second Edition,
WITH CORRECTIONS AND ADDITIONS,

ILLUSTRATED WITH NUMEROUS ENGRAVINGS ON WOOD.

BY JOHN SPROULE.

DUBLIN:
WILLIAM CURRY, JUN. AND COMPANY;
W. S. ORR AND CO., LONDON; AND FRASER, AND CO., EDINBURGH.
MDCCCXLII.

DUBLIN:
PRINTED BY GRAISBERRY AND GILL.

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My Lords and Gentlemen,

I cannot more appropriately introduce my book to the notice of the Public, than by dedicating it to a Society having for its object the improvement of the art of which it treats, and who has so zealously set about carrying that object into effect. In soliciting the patronage of your Society for the present undertaking, permit me to indulge the hope that it may, in some degree, contribute towards the extension of an improved system of agriculture, and thus facilitate the object which your Society has in view.

I remain,
My Lords and Gentlemen,
Your obedient Servant,
THE AUTHOR.

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PREFACE.

Among the many peculiar endowments bestowed upon man, there is none of greater importance than the power which he possesses of increasing the means of his own subsistence. Agriculture is, therefore, the parent of every other art, and it is only after certain advances have been made towards the introduction of an improved system of cultivation—when the soil can be made to support a much greater number than those employed in labouring it—that one portion of the community can devote themselves to mental cultivation, and thus elevate the moral and intellectual character of society.

On endeavouring to form an estimate of the extent to which man possesses command over the means of subsistence, we are apt, at first sight, to conclude that it is all but indefinite. But on investigating the real state of the matter, we find that it is only under certain circumstances, that the desired results can be obtained; that it is, in fact, only by performing certain processes in a peculiar manner, and at a particular period, that the husbandman can obtain a produce from his land calculated to reward him for his labours. From this it might be inferred, that an essential preliminary in the study of agriculture would be to acquire a certain knowledge of the principles on which it is founded, as a sure guide to the practice of the art. Such, however, is not the case. Agriculture has as yet derived comparatively little assistance from the elucidation of principles, experience having for so far been the only guide of the husbandman. By exercising the faculty of observation, and, from experience of the past, depending on the constancy of the seasons and their effects, he may at length so modify his practice as to become a good farmer without the slightest knowledge of the principles on which his operations are founded.

Agriculture is, in fact, truly an experimental art, and its present state, in the more improved districts of the United Kingdom, abundantly testifies that it may be brought to a considerable degree of perfection without the aid of science. But it is also a scientific art, inasmuch as the practice is right or wrong just as it coincides, or disagrees, with the established laws of nature, which it is the object of science to investigate. The mere practical farmer is aware, from experience, that he will attain his object by the adoption of a certain line of procedure; but were he also aware of the circumstances influencing the desired results, it does not follow that this information would not suggest the propriety of modifying his practice to make it more consistent with the economy of nature. The importance of science to agriculture is every day becoming more apparent; and it is to be hoped, that scientific investigations, connected with such an important department of our national industry, will for the future be directed to really practicable objects, instead of the abstruse and fanciful speculations so frequently indulged in, calculated to mislead rather than to instruct, and instead of serving to lead the cultivator to proper objects of inquiry, tending to confirm him in a too presumptuous empiricism.

Although the principles upon which an improved system of agriculture is founded are general in their application, the practice deduced from them which it may be expedient to adopt, is determined chiefly by local circumstances. Thus the general character of the agriculture of a country is determined by the soil and climate, and, though in a lesser degree, by the character of the inhabitants. The plants to be cultivated, the order in which they are to follow each other, as well as the periodical operations of the season, are regulated by the soil and climate; and these are extremely various. Even within the limits of a single country great variations of soil and temperature will be found, arising from difference of elevation, latitude, prevailing winds, and other causes, and the practice of the farmer must accordingly be varied to suit the particular circumstances of his case. In the management of live-stock, too, the farmer must be guided by the character of the soil and climate, both as regards the varieties which it may be expedient to select, and the quantity and quality of the food to be provided for them. In treating of agriculture, therefore, as a practical art, it is obvious that some given condition of climate and country must be assumed, to which the system described must have especial reference; and from a thorough knowledge of the details of a system suited to the assumed circumstances, little difficulty will arise in adopting the practice to other and dissimilar cases.

In the compilation of the present volume, these considerations have been kept steadily in view. A system of agriculture has been described suited to the climate and soil of this country, which experience has shown to be economical and capable of being reduced to practice. In the details of cultivation, and other operations which the farmer is called on to perform, the most minute directions have been given to enable him to carry the system described into effect without difficulty or the chance of failure; and it is conceived that even in the case of a farmer possessing the slightest practical knowledge of his art, who had never seen the operations performed, little difficulty would arise in carrying them into execution, by following the directions given in this treatise. To the more experienced farmer, this minuteness of detail may be irksome, but it must be remembered, that the object in view is not so much to instruct the proficient as the mere tyro; and in the latter case attention to minutiæ will be found of the utmost importance. Nor is the management of live-stock of less moment to the cultivator than the production of crops, and in this case too the like care has been taken to treat every department with as much minuteness as the limits necessarily assigned to the work would admit. Without fear of being considered egotistical, it may be asserted that the reader will find in this treatise such a body of information on the management of live-stock in its various departments, as he will rarely meet with in any similar publication.

While the chief claim of the work to public patronage is its practical character, the science of agriculture has not been forgotten. The attention of the reader is directed to the nature and properties of soils, the substances to be applied to them with a view of increasing their fertility with their mode of action, and the various operations and processes of tillage to prepare them for the cultivation of plants. As introductory to the cultivation of plants, a succinct account of the physiology of vegetation has been attempted, as being of the utmost importance towards laying the foundation of a rational and economical system of culture; and in this department the practical application of the subject has been kept steadily in view. On the same plan a section has been appended to the portion of the work devoted to the management of live-stock, in which an outline has been given of animal physiology, including the principles to be observed in the breeding, rearing, and feeding, and general treatment of the domestic animals. In this department of the work the object has been to awaken the attention of the reader to the importance of the subject, and for further information he is referred to the various elementary works in the different departments.

In the execution of this task the Author lays little claim to originality. There is not, perhaps, a single process described which has not been long in practice in the more improved districts of the kingdom, and most of which has been already described in one or other of the numerous agricultural publications of the present day. In these descriptions, too, the language of others has often been employed, either abridged, or with additions, according to circumstances. In this respect the Author has particularly to acknowledge his obligations to Mr. Youatt's valuable Treatises on the Domestic Animals, which should be in the hands of every farmer, as manuals on which he may place the most implicit reliance. Other authorities are generally acknowledged in foot notes throughout the work.

DUBLIN, *February* 1*st*, 1842.

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A TREATISE ON AGRICULTURE.

I.—SOILS.

I.—NATURE AND FORMATION OF SOILS.

THE fine powdery materials which have been formed by time from the gradual disintegration of the various mineral bodies in nature being ground down, blended, and intimately incorporated with each other, and also with various proportions of organic matter, constitute the upper portion or covering of the globe which is termed the *soil.* The more solid and less reduced substances, which have been excluded from the influence of the atmosphere and other natural agents, form the subjacent stratum, which is called the *subsoil.* The surface is composed of the same materials as the subsoil, with the addition of animal and vegetable matter, in different stages of decay, intimately mixed with it; and we perceive a change in the external appearance of the surface, wherever there is a change in the composition of the subjacent stratum. In uncultivated ground, the soil is rarely more than a few inches in depth, unless in hollow parts, into which it has been washed by the rains; and, in cultivated soils, their depth is generally the same as that to which the implements of tillage have penetrated.

To form a just idea of soils, we have only to conceive different rocks to be decomposed, or ground into parts and powder of different degrees of fineness, some of their soluble parts dissolved by water, and the whole mixed with larger or smaller quantities of the remains of animal and vegetable substances. The influence of heat and moisture tends to facilitate the gradual disintegration of even the hardest rocks; and as soon as the smallest portion of loose matter or earth is formed on their surface, traces of an obscure vegetation begin to manifest themselves. Lichens of various kinds spring up, one generation succeeding another, until, of their decayed and partially decomposed fragments, a soil is prepared for the reception of the mosses. These in their turn decay, and their decomposition affords a certain quantity of organic matter, which mixes with the disintegrated portions of the rocks; and in this improved soil other kinds of plants are capable of subsisting. Meanwhile, the atmosphere still exerting its influence on the surface of the rocks, and the roots of the plants penetrating into their fissures, an augmentation to the mass of the soil is preparing, so that by such slow and gradual means a soil is formed in which even forest trees can fix their roots. Thus that which was originally a bleak and ominous mass of rock, became capable of supporting successively the various tribes of plants, and fitted to reward the labours of the cultivator.

In situations favourable to vegetation, the depth of the soil and the quantity of vegetable matter will be constantly increasing, unless part of the produce is carried off by man, or consumed by animals; and, if so situated that it can receive water from a higher district, it becomes spongy, approaches to a peat in its nature, and is at length incapable of supporting the nobler classes of vegetables.

The natural decomposition of plants is indeed favourable to the production of peat or moss, unless counteracted by some peculiarity of situation or climate, or by artificial means. The causes which resist the formation of peat proceed primarily from the soil and climate, and subsequently from that general plan of management which the climate and soil have induced man to adopt, in order to secure the most profitable return for his labours. But, although the climate and soil, when uncontrolled, naturally produce peat, yet they also furnish the means of counteracting its immediate formation. Wherever heavy and long-continued rains occur, they wash from the higher grounds, or bring from the interior of hills, immense quantities of sand, which, scattered over the surface, enter into combination with the remains of decayed plants, and prevent the formation of peat from their decomposition. The obstructions which man opposes to its formation, are his stocking the hills and plains with animals which consume the herbage, and his cultivating the soil for agricultural purposes.

Soils are less influenced in their nature and composition by climate than the spontaneous vegetation which they produce. Different climates produce different races of animals and different families of plants; but the mineral kingdom, on which the nature of the soil chiefly depends, is in a great measure independent of the influence of climate, the same description of rocks being found in the equatorial and in the polar regions. The fertility of the soil is affected, it is true, by the climate, but this will be found to arise from the absence or presence of heat and humidity, rather than from any essential difference in the composition of the soil itself.

With certain exceptions peculiar to certain districts or regions, or, speaking more correctly, to certain geological formations, soils are, in a great measure, the same all over the globe. So long as we observe the same rocks occurring in the most distant parts of the world, the fragments of these rocks must be similar in their nature, and the soil which is composed of these fragments must also be similar. Or, if we view soils as consisting not so much of disintegrated as of decomposed rocks, still they must exhibit a greater or less degree of resemblance; although peculiarities of climate, and the different nature of the vegetation in different climates, may give rise to considerable modifications. Thus in the northern and temperate parts of Europe and America, where the decomposition of vegetable matter is slow, on account of the diminished temperature, we find those accumulations of half-decomposed vegetables, which constitute our peat tracts, and which have great influence on the vegetation and aspect of a country; but in the tropical regions, where vegetation is infinitely more luxuriant, decomposition is effected so rapidly, that none of those accumulations can take place. Still, however, even there, a trap or sandstone will produce the same soil as a similarly constituted district in our own country.

The soil, then, is seen to be formed of the disintegrated or decomposed parts of more solid parts or rocks, or of the sediment supposed to have been left by some fluid which formerly held it in solution, or supported it in mixture, generally more or less intermingled with vegetable matter. Sometimes, however, as in the case of peat, it may consist of vegetable matter alone. Occasionally it consists of the disintegrated particles of the rock on which it immediately reposes; but this is seldom the case, and upon the solid rock we now frequently find imposed a variable quantity of matters differing entirely from it.

Soils are essentially different in their elementary nature, according to the particular earths which they contain, and the various proportions in which those earths enter into their composition; but soils possessing the very same chemical elements may be endued with widely different properties, in an agricultural point of view, according to the mechanical state of fineness or coarseness of their particles, and the degree of looseness or firmness of texture resulting from their mode of union.

As the nature of the soil determines the kinds of plants which can be profitably produced, it becomes important that the farmer should be able to ascertain in what these striking differences in texture and quality consist. From the vague manner in which soils are usually described, and from the various acceptations of the same terms in different districts, it is often difficult for a farmer who reads an account of the agriculture of any other district than that in which he resides, to judge what relation the soil which is the scene of these operations bears to that which he occupies himself. A certain knowledge of chemistry is necessary, in order to be able to ascertain the composition of the soil with any degree of accuracy: and this is of importance to the cultivator, for it is only in the accuracy in which soils are described and their composition ascertained, that the best methods of remedying their defects, and improving them by the application of extraneous matters, can be ascertained.

II.—COMPOSITION OF SOILS.

Although soils are so very various in fertility and texture, they are all resolvable into the same constituent parts, and these are few in number. They consist, as already observed, of earthy and organic matters in a state of combination. What is commonly called earth may be considered in two points of view, either as mixed or unmixed with animal and vegetable remains. As originally produced from the decomposition of rocks, earth is destitute of any of these matters; but they very soon enter into its composition, and exist in a considerable proportion in all soils not absolutely barren. The earths found in soils appear very seldom to be united chemically, but are in general mere mechanical mixtures. The organic matters of the soil, with the addition of certain compounds of iron, evidently give to it the peculiar colour by which it is characterized, since the earthy matters are perfectly white in their pure state.

Of the substances which form the constituent qarts of minerals, the most widely diffused is silica. It is found in quartz, flint, and sand. It is from its abundance in quartz, a mountain rock of almost universal diffusion, and in feltspar, which is also one of the most abundant minerals in nature, that silica is important, as forming a principal constituent part of all the loose mineral matter of the earth.

Silica is particularly distinguished by its hardness, stones containing it being used for striking a light with steel. Besides hardness, it possesses the properties of being almost insoluble in water, not being corroded by acids, (except the fluoric,) and little altered by the action of heat. From its hardness and great insolubility, silica is the most durable of the earths. When rocks and even mountains are, in the course of ages, decomposed and reduced to fragments, silicious earth is the matter which remains, forming beds of stones and sand; and, being the last in being reduced to powder, its hardness preventing its being pulverized by the friction produced by the action of water rubbing its particles against each other, it is not easily lifted up and carried away in suspension in rivers and streams. Hence sand and silicious pebbles form the chief part of the beds of rivers and of the sea. Many of the other matters of rocks act the part of a cement, binding the particles of silica to each other. Thus silica may be said to be the bones of the earth, giving hardness and firmness, and rendering rocks durable, so that they can better resist the forces that tend to destroy them. When pure, it is of a white colour, but in nature it is generally found more or less coloured from the presence of other matters. Rock-crystal, or quartz, is a very pure variety of silica. This earth may be obtained by exposing colourless rock-crystal for some time to a red heat, and then pounding, this being easy after the mineral has been heated.

Though silica does not redden vegetable blues, yet it enters into definite compounds with the different bases, and forms saline combinations which are distinguished by the name of *silicates*, and is hence called *silicic acid* by some writers on chemistry. Like other weak acids, it is capable of entering into a great variety of combinations with bases, and these are frequently so intimate that no other acid is capable of removing the base, and setting the silica at liberty. The different kinds of glass consist of two or more silicates melted together, the varieties being produced by the different proportions of the constituents employed, the nature of the alkali, or the presence of foreign matters.

Alumina, next to silica, is the most abundant of the earths, and is a principal ingredient in all soils not essentially sandy in their nature. It is a leading ingredient in the composition of clays, and gives them that softness, plasticity, and adhesiveness for which they are distinguished. In combination with silica, it is found in every region of the globe, and in rocks of all ages, being a constituent of the oldest primary mountains, of the secondary strata, and of the most recent alluvial depositions. The different kinds of clay of which brick and earthen ware are made, consist of the hydrate of alumina in a greater or less degree of purity. It commonly appears in rude amorphous masses, but it is also sometimes found beautifully crystallized. The ruby and the sapphire, two of the most beautiful gems with which we are acquainted, are composed almost solely of alumina.

Pure alumina may be procured from common alum, the sulphate of alumina and potassa, whence it derives its name. It has neither taste nor smell, and is quite insoluble in water. It has, however, a powerful affinity for water, attracting moisture from the atmosphere with avidity, and, for a like reason, it adheres tenaciously to the tongue when applied to it. Mixed with a due proportion of water, it yields a soft cohesive mass susceptible of being moulded into regular forms, a property upon which depends its employment in the manufacture of pottery. When once moistened, it cannot be rendered anhydrous except by exposure to a full white heat; and in proportion as it is deprived of moisture it diminishes in volume. Like silica, it appears to possess the properties both of an acid and of an alkali;—of an acid, by uniting with alkaline bases, such as potassa, lime, and baryta; and of an alkali, by forming salts with acids.

The next earthy constituent of soils is lime. This substance is never found in a pure state, being always in combination with some of the acids, but chiefly with the carbonic. In this form it is very abundant, and constitutes the numerous varieties of limestone, marl, chalk, and marble. United with sulphuric acid, it forms gypsum, and with the phosphoric, it is a principal ingredient in bone.

Lime is obtained with facility from the carbonate, by exposing it to a strong heat, which drives the carbonic acid off, and that which remains is the caustic earth, to which we apply the name of *quicklime.* When exposed to the atmosphere in this state, it has a great tendency to return to the original form of carbonate, in undergoing which change it first absorbs a large quantity of water, and then assumes the form of slaked lime, or according to chemical nomenclature, has become a hydrate. This hydrate, in its turn, rapidly absorbs carbonic acid from the air, and thus, in a short period, the burnt lime returns to its original condition, with this difference, that it was formerly in large stony masses, but it is now in a state of fine powder. The quicklime, when first made, is caustic and burning to the tongue, renders vegetable blues green, and is soluble in water; but after exposure to the atmosphere, when it has again entered into combination with carbonic acid, it loses all these properties, its solubility and its taste, and will effervesce with any of the mineral acids, as in its original state.

In procuring lime on the large scale for agricultural purposes, the common limestone of the country is employed; but if lime of great purity be required, it should be prepared from pure carbonate of lime, such as Iceland spar, or Carrara marble; or it may be procured from any of its salts by a chemical process. In this state it is one of the most infusible substances known, fusing with difficulty even with the aid of the oxy-hydrogen blowpipe. It is in a slight degree soluble in water, the solution having a harsh acid taste, and turning vegetable blues to green. Quicklime, in its pure state, whether in powder or dissolved in water, is injurious to vegetation, rapidly decomposing every vegetable substance; but lime in a state of combination with carbonic acid is a useful ingredient in soils.

From the facility with which limestone is converted into powder, it is of great importance in an agricultural point of view; and much of its importance, doubtless, arises from this circumstance alone;

for could the other earths be applied to the soil in their pure state, or could we reduce them to powder by mechanical or chemical means, we should be able to apply them, in a form calculated to increase the productive powers of the soil.

Magnesia is not nearly so abundant as any of the earths already mentioned. When procured in a pure state, it is a fine white earth, very light, and extremely insipid. It exists in nature in various states of combination with acids and other earths, and is found in various mineral springs, and in the waters of the ocean. Magnesia is a principal ingredient in three rather singular mountain minerals, *mountain leather*, *mountain wood*, and *mountain cork*, so termed from their possessing much of the softness, flexibility, and lightness of leather, wood, and cork, being so light as to float on the surface of water. The minerals of which it forms a part, generally feel soft and unctuous. It exists largely in serpentine, chlorite-slate, and hornblend; and thus, being a constituent part of many rocks and minerals, it forms a considerable part of some soils.

The mineral substances, then, which enter most largely into the composition of rocks and soils, are silica, alumina, lime, and magnesia; and when any of these prevails, giving its character to the soil, it is frequently convenient to distinguish it accordingly, as being silicious, aluminous, calcareous, or magnesian. Where silica prevails, as in the case of many sands, we may call the soil silicious; where clay prevails, we may call the soil aluminous; where lime exists in quantity, as in the case of chalk, we may call the soil calcareous; and where magnesia prevails to such an extent as to give the character to the soil, it may be termed magnesian.*

The next widely diffused substance, forming a constituent part of soils, is the oxide or peroxide of iron. These substances differ merely in the latter containing an additional quantity of oxygen. Oxide of iron is found in different proportions almost every where, in rocks and soils; and, in many cases, it communicates colour to the minerals with which it is combined. Its influence on the productive powers of soils has not been well ascertained; some soils where it exists being extremely barren, while, in some fertile soils, it exists in large quantity.

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* Elements of Practical Agriculture, p. 16.

The alkalies, soda and potassa, are also occasionally found in soils, being extensive products of the mineral kingdom. They are never found in a pure state, being combined with acids. The former, combined with carbonic acid, forms the soda of the shops, and the latter, in combination with the same acid, is known by the name of pearl ash.

Besides the saline compounds formed of the earths which have been mentioned, the earths, baryta and strontia, sometimes form a part of soils. They rarely, however, exist in considerable quantities; and not being widely diffused, they are not deserving of being separately noticed in this place.

III.—CLASSIFICATION OF SOILS.

Having treated of the primary ingredients in soils, we now come to a description of their varieties, as they occur to the husbandman. A clasification and arrangement of soils, which will identify their peculiar properties, and show the kinds of crops they are best fitted to produce, will be that which will be found most satisfactory. According to the nomenclature in general use, soils are distinguished as clayey, sandy, gravelly, and peaty, each possessing certain characters and degrees of fertility.

The clayey soils have for their distinguishing characteristics the adhesion of their parts, and the retention of moisture; and these characters alone will enable even the inexperienced to distinguish them. They adhere to the feet when damp, they imbibe moisture slowly, but do not transmit it freely for the use of plants; and when strong clay soils are brought quickly from a wet to a dry state, they approach to the state of bricks previous to their being burned.

A general character of clay farms is, that although the crops are cultivated at a great expense, yet they are exceedingly productive, and generally of a superior quality. Much attention is required with regard to the time, or rather the state of the soil, before the operations of tillage can be commenced. If too dry, it turns up in impenetrable masses, very difficult of being reduced to the requisite degree of fineness for sowing; and if too wet, it is worked into mortar, poached into holes by the feet of the cattle, and is altogether unreduceable by the action of the harrows. Suitable seasons must therefore be chosen for conducting the operations of tillage on clay soils. At the first ploughing, the clay comes up in large clods, but the oftener it is acted upon by the implements of tillage, at the proper time, the more is the cohesion of its particles broken, and the more easily can the roots of plants penetrate the soil for their support. The due temperament for working them is when the clods can be crushed by the action of the roller.

This species of soil exhibits considerable variety, and is also extensively diffused, in some places occupying extensive districts. In the course of large rivers toward their mouth, or rather in the great valleys through which such rivers take their course, vast deposits of clay are usually found, and the soil here is generally fertile. Clayey soils are not, however, confined to the valleys, but abound wherever alumina is a predominating ingredient in the composition of the substratum. The poorer class of clays forms, perhaps, the most unprofitable description of soil which can engage the attention of the husbandman. The produce of such soils in inconsiderable, and they are tilled with difficulty; and the herbage is not only small in quantity, but it is also coarse and little nutritious. The richer clays, however, are valuable, and are peculiarly adapted to the growth of wheat; hence such soils are familiarly termed *wheat* soils by the husbandman.

The sandy soils are distinguished from the clayey by their smaller degree of tenacity; and, like them, they are of all the degrees from barrenness to fertility. From their tenuity, they cannot be cultivated with advantage without the aid of manures and consolidating substances, to counteract their poverty, and to prevent the continual evaporation of moisture from them, which would otherwise take place. A degree of tenacity and firmness may be given to sandy soils by the treading of sheep folded upon them, while they are much fertilized by the dung and urine of the animals.

Although the poorer sands are almost always marked by the scantiness of their natural herbage, yet sand, without losing its distinctive character as a soil, may possess a greater degree of cohesiveness in its particles, and be fertile by nature, or be rendered so by art. The crops raised on sand are sooner ripe, and some descriptions are of finer quality than those from richer and stronger ground, but they are for the most part deficient in quantity. The liability of sandy soils to suffer from drought is a great drawback on their cultivation. At the same time no land pays better for improvement, provided the means are at hand. Whatever application has a tendency to give it compactness, will also make it more retentive of moisture, and thus correct one of its greatest defects. The richer class of sands is fitted for the production of every kind of herbage and grain; and is especially adapted for the cultivation of bulbous and tuberous rooted plants.

Gravelly soils bear a great resemblance in many particulars to the sandy. They generally contain a larger proportion of the undecomposed matter of the rocky basis of the soil, which also exists in a less minute state of division of its parts. Where this undecomposed matter is great, the soil, as a matter of course, is barren; and its fertility depends in direct proportion on the quantity of organic matter in its composition. The loose texture of gravelly soils renders them unfit for the production of wheat and beans; but they are admirably adapted to the growth of barley or oats. Unlike many sorts of sands, the quality of the grain produced will always be found equal to its appearance; and, like sands, they are well suited to the culture of the different plants raised for their roots and tubers.

The lighter class of soils, namely the sandy and gravelly, may further be divided into calcareous and silicious, according as lime or silica predominates in their composition. It is, indeed, of importance to observe this distinction; for the soils containing lime will be generally fertile, and those containing silica in large quantities will be barren. The former merit the appellation which is commonly given to them, being termed rich or kindly soils, as they retain the fertilizing effects of the manures which have been applied to them for a length of time. Silicious soils, on the contrary, are called hungry soils; for the vegetable and animal matters which may have been applied to them, not being attracted by the earthy constituent parts of the soil, are more liable to become decomposed and dissipated by the action of the atmosphere, or carried off by water.

We now come to treat of the last division of soils, namely, the peaty.

In treating of the formation of soils, it has been said that they consist of the detritus, or worn-off portions of rocks, combined with organic matter, and that from the almost naked rock on which the seeds of parasitic plants can hardly vegetate, a soil has been slowly and gradually formed by the continued disintegration of the rocky materials combined with an increasing quantity of organic matter, in which the most stately trees will grow and flourish. Peaty soils form, however, an exception to this theory. They are formed from very opposite causes; and it is interesting to contemplate how a similar effect may be produced by very different means, and the earth, which supplies almost all our wants, may become barren, alike from the excessive application of art or the total neglect of it. Continued pulverization and cropping without manuring will certainly produce a hungry, barren soil; and the total neglect of fertile lands will, in certain situations, produce peat bogs, by their accumulated vegetable products.

The matter comprising the soils of this class varies exceedingly according to its situation and distance from the surface; but in all cases it retains the general characteristics of its origin, from the quantity of the stems and other parts of plants which it contains, either entire or in a partial state of decay. At the surface, it may be fibrous, and of a brownish grey colour; and lower, it may be friable, scaley, of a light brown colour, and with few fibres. Still lower, it may be compact, of a deep brown, with an even fracture, and of greater specific gravity. Lower still, it may be yet more compact, with a smoothish fracture, of a pitch brown colour, hard, or even brittle, and sometimes capable of considerable polish. Thus, in its texture, it varies from fibrous to compact; it is of a less specific gravity than water, when dry; plastic in its moist state when compact, and in some degree even when fibrous; and capable of burning with flame and smoke. Wherever wood, bent, or grass of any kind goes to waste, or falls down and is decomposed, its remains are changed into moss if the necessary degree of humidity be present. A certain temperature is also essential in producing this change, since under an increased temperature a total, instead of a partial, decomposition of the vegetable matter would be effected; hence it is only in the cold and temperate regions of the earth that peat is to be found.

Peat earth or moss, then, may be called an adventitious soil, and in its natural state, incapable of producing plants or grass proper for the support of man or beast. From its vegetable composition it would seem to contain the necessary elements of fertility, but this is not found to be the case. The antiseptic quality of the moss is found to be inimical to vegetation, and, instead of accelerating it, changes every vegetable substance with which it comes in contact into a substance analogous to itself, which is finally incorporated with it.

The improvement of peat earth, so as to render it fitted for agricultural purposes, is an important consideration in a country in which it abounds to such a considerable extent as it does in Ireland. A chief and striking feature of the topography of the country is the extensive tracts of bog which are distributed over the surface of the island. The improvement of these has long engaged the attention of the economist, as affording employment for a great portion of the unemployed population of the country. Capital has been withdrawn from this speculation in consequence of the over-sanguine expectations which were entertained at the commencement of the operations, but which were never destined to be realized; although there is no doubt that the greater part of the bogs throughout the country would afford profitable returns for the capital expended in their improvement, were it judiciously effected.

The term *loam* has been mentioned in describing the varieties of soils. Under this denomination is included that kind of soil which appears to be an intimate mixture of all the others. The term is of course vague and unintelligible, unless when some qualifying term is prefixed to it indicative of its composition, as a clayey loam, sandy loam, or gravelly loam, according as either clay, sand, or gravel abounds. Peat earth itself, it has been said, may be converted into loam, by a judicious admixture and combination of the earths with it. It is therefore difficult to describe it with precision. It is always friable in its composition, readily admitting air and moisture, and as readily discharging all excess of the latter, retaining only as much as is necessary to promote vegetation; and neither liable to be parched in summer, nor drenched and chilled with surface water in winter. The facility with which it admits of culture is also another distinguishing characteristic. It is suitable for every kind of crop, and every system of husbandry. The nearer indeed any soil approaches to the state of loam, it is the more valuable.

The foregoing arrangement will be sufficient for every practical purpose. The farmer, however, chiefly regards soils with relation to their fertility, independent of their composition. A main distinction between soils in practice, is founded upon their comparative productiveness, and this is the distinction which is most important with regard to mere value. We constantly refer to soils with reference to their good and bad qualities, without adverting to the particular circumstances which render them of good or bad quality. But those other distinctions which are derived from their constitution and texture are important when we regard the manner of cultivating such a soil; for the same method of tillage, and the same succession of crops, as will be afterwards seen, do not apply to all rich soils, or to all poor soils, but are determined by the character of the soil, as derived from its other properties.

IV.—THE QUALITIES OF SOILS AS DEMERMINED BY THEIR SPONTANEOUS PRODUCTIONS.

The characters of the soil, with respect to its fertility, may also be determined by its spontaneous vegetable productions. The nature of the soil, with respect to its texture and composition, will generally be best determined by an examination of the substance itself; but its fertility or powers of production may be judged of from its natural produce—in part from the kinds of plants which are peculiar to it, and in part from the luxuriance with which they grow.

The spontaneous productions of the soil form the most certain indications of its fertility; for, while the practical cultivator would not engage with land, without hesitation, of which he knew only the results of a chemical analysis, or examined by the sight and touch a specimen brought to him, every farmer, on an examination of its vegetable productions, would, in general, feel little difficulty in deciding as to its value for cultivation.

In a previous part of this article it has been seen that the soils of all countries bear a close resemblance to each other, being the result of the disintegration or decomposition of mineral substances, which are universal in their distribution. But the case is very different with regard to the plants which grow upon these soils; and to any one at all acquainted with the distribution of vegetables over the globe, it would never occur to classify them according to soil exclusively. The sands of Southern Africa, and the sands of Northern Europe present no common features of vegetation; nor are the marshes of Surinam and those of Lapland characterized apart by peculiar classes of plants. In short, every species of plant has a certain range of its own, beyond which it does not extend. Every zone from the equator to the pole is distinguished by a different vegetation, and different regions have their peculiar plants, so that a Norwegian landing at Rio Janerio finds himself, as it were, in a new world, the vegetation of which recalls nothing of that from which he has come, whatever the geological or geographical features of the country may do.

In attempting, therefore, to solve a question having reference to the relation existing between vegetables and soils, any general results that might be elicited seem to be beyond the limits of our present state of information. Vegetation is affected, in an especial degree, by temperature, and in no considerable tract will the temperature be found to be uniform. It is only, then, within narrow limits, and under given conditions of climate, that the nature of the soil can in any degree be indicated by the plants produced on it.

The quality of the soil is indicated with greater certainty by an examination of the state of luxuriance of the plants produced, than by ascertaining the peculiar genera and species growing on it. There are few plants spontaneously produced on land fit for cultivation, that are confined exclusively to any peculiar description of soil, or any particular locality; and any general conclusions arrived at, respecting the quality of the soil, from the particular plants produced, cannot be implicitly relied on. Within certain limits, as those of a country having throughout nearly the same climate, with respect to humidity and temperature, it might be supposed that particular soils would be indicated by peculiar plants; but even within the circumscribed limits of a country, great varieties of climate may exist, arising from elevation and exposure: and any calculations founded on this datum would prove, in many respects, erroneous. Besides, the several sorts of soils pass into each other by almost imperceptible gradations, and their productive powers being influenced to a great extent, both as to the species of plants produced, and their luxuriance, by the absence or presence of moisture in the soil, as to produce plants of the most opposite qualities and natural habits, in circumstances apparently similar.

The fertility of soils, generally speaking, is denoted by their powers to yield the useful plants; and it is a law, with few exceptions, that the poorer the soil is, the less nutritious are the plants which, in its natural state, it produces. The soils of the poorest class produce mosses, lichens, and heaths, which are less nutritious than the grasses. As the soil improves in quality, the grasses become intermixed with these inferior plants. As improvement advances, the proportion of the grasses to that of the other plants not only increases, but they become more valuable in their kind, and more numerous in their species; and, in like manner, the leguminous, and other herbage plants, indicate, by their kinds and greater numbers, the increasing fertility of the soil.

Cultivation and local circumstances having such influence on the peculiar vegetation of any particular district, little confidence can be placed in lists of plants indicative of particular soils. A total change may be affected in the vegetation of a tract of country, by cultivation, and the same plants will not again be found growing in it, no matter how long it may be afterwards laid down to grass. The farmer, or indeed any one accustomed with country objects, will, however, have little difficulty in determining the character of the soil from the general appearance of its vegetation, without even ascertaining the name of a single plant growing on it.

V.—RELATION EXISTING BETWEEN THE SOIL AND SUBSOIL.

The value of the soil for agricultural purposes is affected in a great degree by the nature of the subsoil upon which it is incumbent. Hence the necessity of the farmer becoming acquainted with the nature of the subjacent strata as well of the superincumbent.

The subsoil, it has been said, is distinguished from the soil by the absence of animal or vegetable remains in its composition. It lies immediately under the soil, and extends to an indefinite depth. Where it is distinctly terminated by another stratum of a different nature, at a depth capable of influencing the soil, then a second subsoil may be enumerated. The soil may be limited in its superficial extent by the solid rock appearing at the surface, and where this is the case, no soil is said to exist in such places. The subsoil, however, may be either loose matter or solid rock; for the latter is considered as subsoil as much as a substratum of clay, marl, or sand would be; but where there is no soil, there cannot, of course, be any subsoil.

The subsoil is deserving of attention on various accounts. By examining the subsoil, information may be gained regarding the soil itself; for the materials of the latter are often similar to those which enter largely into the composition of the former, though the substances in the soil are necessarily altered by various mixtures in the course of cultivation. The subsoil may be of use to the soil, by supplying its deficiencies and correcting its defects. The hazard and expense of cultivating the surface are often considerably augmented by defects in the lower stratum.

In cases where the soil is directly incumbent on the solid rock, it would seem that it had been formed by the gradual disintegration of the rocks below, and, hence, is of the same composition as the rock upon which it rests. This is chiefly the case with the soils of mountains and elevated grounds; for, in plains, the soil is generally formed by the intermixture of the parts of different and distant strata. Where the soil rests directly upon the rock, without any considerable intervening stratum of earthy matter, it may be supposed that its quality will be affected by the nature of the rock from which it is formed. Thus the soils of certain rocks are more or less productive than others. Those, for example, formed directly on granite, quartz, serpentine, and generally on the rocks termed primitive, are greatly deficient in fertility. The soils formed from magnesian limestone are often infertile, while those of the other secondary calcareous rocks are productive.

But soils do not generally rest directly upon the rock. More frequently they lie upon earthy strata, easily distinguishable from that which is properly called soil. Now, all earthy subsoils may, like the soils themselves, be distinguished into two divisions, of stiff and light, or rather of retentive and porous. The retentive are those which contain a great proportion of clay, and which are cohesive in their parts, and little pervious to fluids; the porous are those of a looser texture, and they consist, more or less, of sand and gravel.

A retentive clayey subsoil is in general found to be highly injurious to vegetation. Where the soil is incumbent on a subsoil of this quality, it is constantly soaked with water, and is tilled with difficulty. The retention of an undue quantity of moisture diminishes the beneficial action of the manures which have been applied to the land, and the crops on such soils make little progress. Hence, their grain is of inferior quality, and, when in grass, their herbage is coarse.

A porous subsoil is uniformly attended with this advantage, that, by its means, all superfluous moisture is absorbed. Below clay, and all the varieties of loam, an open subsoil is particularly desirable. It is favourable to all the operations of husbandry; it tends to correct the imperfection of too great a degree of absorbent power in the soil above; and it promotes the beneficial action of manures, contributes to the growth and preservation of seeds in the soil, and insures the future prosperity of the plants. Hence it is that a thinner soil, with a favourable subsoil, will produce better crops than a deeper one incumbent on wet clay, or on cold or non-absorbent rock.

But not only is the soil affected by the depth and texture of the subsoil, but by its quality. There are cases when, from natural revolutions, that which is properly the soil forms the lower stratum, as in the case of sandy downs, where the original surface had been covered by the sand; but in general, the lower stratum is far less suited to the nourishment of plants, and in many cases contains matter which, if in too great abundance, is exceedingly injurious to vegetation.

Whether the subsoil be retentive or porous, the soil which rests upon it should be of good depth; and in proportion to that depth will it be affected by the nature of the subsoil. If a retentive subsoil is placed very near the surface, not only is the soil too shallow for the purposes of vegetation, but it is too easily affected by the alternations of dryness and moisture; and if, again, a porous subsoil be very near the surface, the roots of the plants, as in the other case, not only have not sufficient space to extend themselves, but the moisture of the soil is too easily exhausted by heat to the injury of vegetation.

VI.—MEANS OF INCREASING THE PRODUCTIVE POWERS OF SOILS.

Having now explained the nature and properties of soils, their formation, composition, and varieties, with the connexion between the soil and subjacent strata, it remains to point out the means at the command of the farmer for maintaining or increasing their fertility.

Considering that the soil is a natural production, and that the labour of art has had nothing to do in its formation, it might, at first sight, be imagined, that it was beyond the reach of art to make any sensible change in its composition and properties: and although, by long-continued exertion, the nature of the soil may be greatly modified, and the cause of infertility, to a certain extent, removed, yet the work is, in most cases, one of great labour, and should not be undertaken without the utmost previous consideration. Well-directed labour is, however, capable of effecting great and important results, and has already done so much towards improving the soil of the country, that the improvement of the soil may be regarded as one of the most important objects which can occupy the attention of the husbandman.

A knowledge of the nature and properties of soils is absolutely necessary before their improvement can be undertaken with even the slightest chance of success. The soil may be barren from the presence of some particular ingredient, and, were the cultivator aware of this, the noxious substance might be neutralized with little difficulty. It may be deficient in some particular substance which is perhaps not far distant, and which, therefore, might be easily added to it. It may be infertile from superfluous moisture; but this cannot be thoroughly removed without a previous knowledge of the structure of the soil, and of the mechanical arrangement of the subjacent strata.

In order that the productive powers of soils may be developed to the fullest extent, they must consist of mineral matters and organic substances, combined together in definite proportions; and where any of the ingredients either predominates, or exists only in small quantity, the constitution of the soil is defective. It must also be constituted so as to maintain such a degree of moisture, both in very dry, and in very wet seasons, as to give only a healthy supply to the plants ; and all our fertile soils, accordingly, have a power of supplying themselves with moisture, and of retaining it only so long as it may be required.

The mechanical state of division in which the component parts of the soil exist seems to have much greater influence on its fertility than the chemical agency of its constituent particles, inasmuch as they would seem to have been saturated with the principles with which they combine, and which they imbibe from the atmosphere ; and, therefore, in general, until they are decomposed by other agents applied by man, they remain inert, without exerting a chemical action upon each other, or a stimulating one upon the roots of vegetables imbedded in them. Thus it is known that lime applied to land for agricultural purposes, by becoming converted into a carbonate, soon loses all its energy, and no longer possesses a quickening power upon the living, nor a decomposing one upon the dead vegetation of the soil, with which it has been intermixed. The manner in which soils operate upon vegetables, therefore, depends upon their circumstances as to compactness or looseness, impregnation with water or dryness, exposure to sun or weather, or other accidental circumstances, among which the degree of comminution of the particles occupies a prominent place.

Soils, then, may be rendered better fitted for answering the purposes of agriculture, by the following means:

1. By an alteration of their constituent parts.
2. By changing their relation with respect to moisture.
3. By changing their texture, depth, and properties by tillage.

The constituent parts of soils may be altered by the addition or subtraction of certain ingredients in which they are deficient, or contain in superabundance ; and also by the chemical change of some part or parts by incineration.

In ascertaining the composition of soils, with a view to their improvement by an alteration of their constituent parts, any particular ingredient which is suspected to be the cause of their unproductiveness should be particularly attended to. A soil of good apparent texture containing certain compounds of iron, will be sterile, but the obvious remedy is the application of lime, which will neutralize their injurious effects. If there be an excess of calcareous matter in the soil, it may be improved by the application of sand or clay. The best natural soils are those the materials of which have been derived from different strata, and are minutely divided and intimately blended together; and in improving soils, the cultivator cannot do better than imitate this process of nature. Thus we may add silicious matter when the soil is too stiff, and aluminous matter when it is too loose, until the required degree of consistency be attained.

A certain change in the constituent parts of the soil is effected by the application of manures, which so frequently takes place while the land is in cultivation. The soil is found to be deprived of certain ingredients during the progress of vegetation, and it is also ascertained that these substances are again supplied by the application of organic matters to the soil, whether of animal or vegetable origin. Besides supplying vegetables in a growing state with that food which they require, the application of organic substances also tends to change the texture of the soil, and otherwise improve it; and accordingly all good soils are found to contain a large proportion of them. It must be remembered, however, that such matters are exhausted by a series of cropping; hence it is, that in supplying organic matters a temporary food is provided for plants, which, in all cases, extends its agency only to a certain number of crops; but when the soil is rendered of the best possible constitution and texture with regard to its earthy constituents, its fertility may be considered as permanently established.

The removal of superabundant ingredients in soils may also be occasionally effected, and this is sometimes one of the simplest and most effectual means of their improvement. It occasionally happens that the surface of a soil, otherwise well proportioned, is thickly covered with peat, with gravel, or with small stones. In such cases a simple and effectual mode of improvement consists in removing the superabundant materials. This can seldom be put into practice on a large scale with such heavy materials as gravel or stones; but improvements in the case of peat have, in this manner, been repeatedly effected on a large scale. Sometimes this mode of improvement may be carried into effect by turning down the surface, and raising up a stratum of better earth.

Further, the constituent parts of soils may be altered by incineration, or, as the practice is more usually termed, paring and burning. The soils improved by this operation are all such as contain too much dead vegetable fibre, and which consequently lose from one-half to one-third of their weight by incineration, and all such as contain their constituent parts in an impalpable state of division; but on soils containing a just mixture of the earths, and which have been previously under tillage, torrefaction cannot be useful.

With respect to the second mode of improving soils, namely, by changing their relation with respect to moisture, it may be remarked, that although water is a necessary element in the process of vegetation, yet when supplied in too large quantities, instead of being useful it becomes injurious. The pernicious effects of superfluous moisture are well known to every cultivator. When an undue supply of moisture is present, the operations of tillage are retarded, and even altogether obstructed: and, on wet soils, the produce is not only small in quantity, but also deficient in nutritive properties. In warm countries the soil is comparatively little injured by an excess of moisture, and more frequently suffers from an insufficiency of it; but in a humid climate like that of this country, the operation of conveying away the water which is in excess is an essential one, and, if neglected, the best devised scheme of improvement may fail. It must be evident to any one in the least acquainted with the statistics of agriculture, that by much the greater portion of the arable land of the country is under imperfect tillage, arising from the want of complete draining; and looking even to the best cultivated districts, much of the land will be seen suffering from wet or damp. In this department of agriculture greater improvements have taken place lately than perhaps in any other. The various modes which have been found efficient in practice for the removal of superfluous moisture from the soil, will be treated of at length under the head of Draining.

But although an excess of moisture so generally prevails in this climate, it is not by any means universal, and, in certain cases, the fertility of the soil can be increased by the addition of moisture. In warm climates, this deficiency of moisture is, of course, more severely felt, yet even in our own climate irrigation, or the watering of land, is often attended by beneficial results. Though practicable in the case of arable land, it is chiefly confined to the watering of grass land during the winter and spring months. This curious and interesting branch of rural economy shall be described at length when treating of the management of grass land.

The mechanical division of the parts of the soil, by which an alteration is produced in its depth, texture, and properties, is a very obvious improvement, and applicable to every soil, in proportion to its adhesive texture. Even a pure silicious soil will, if left untouched, become too compact for the admission of air, rain, and heat, and for the free growth of the fibres of the roots of plants; and clay soils will, without pulverization, become so compact in their texture as to produce only fibrous-rooted perennial plants. Annuals, and ramentaceous-rooted plants cannot penetrate such soils.

An important feature in the improved system of drill husbandry is the increased tillage given to the soil during the growth of the crop, and the consequent increased comminution of its parts; and the superior crops which have been obtained off the land since the introduction of that system are, in no small degree, to be attributed to the greater degree of pulverization given to the soil. But pulverization, only effected to the depth of the furrow slice in ploughing, or even to the depth of the soil itself, cannot be regarded as perfect, especially in the case of retentive subsoils; for if the soil be merely loosened only a few inches in depth, in continued wet weather it soon gets into a state unfit for vegetation; the water becomes stagnant, and all the soluble matter in the soil is either washed out, or rendered inactive by being so thoroughly soaked with water as to exclude the air. When the soil, however, is artificially deepened, and the subsoil is also made porous to a much greater depth, the rain and superfluous moisture gradually sink down to the whole depth of the porous stratum, and from thence to the channels previously formed for conveying it off the land. In time of drought the well-pulverized soil will retain a much greater supply of moisture for the nourishment of plants, thus draining off the abundant water during heavy rains, and supplying the means for healthy vegetation at all times.

Deep pulverization, combined with a previous thorough system of drainage, is indeed one of the most important and valuable improvements practised in modern agriculture. The kinds of land to which this species of management is chiefly applicable, are the different varieties of clayey soils, and all such as are situated upon retentive subsoils. Before the introduction of this system these soils were very difficult to manage, but after being thoroughly drained, and pulverized by the action of the subsoil plough, they become the most valuable soils under cultivation, being tilled with little difficulty, and producing valuable crops.

The *chemical* effect of pulverizing the soil is certainly advantageous to the plant in two ways, besides others with which we are very likely at present unacquainted: it renders the soil penetrable to a much greater depth by the roots, or minute fibres of the plant, and consequently render more available any decomposing matters or earthy ingredients contained in it; and it makes it more freely permeable by the atmosphere, rendering in consequence a greatly increased supply, not only of oxygen gas to the roots of plants, but also yielding more moisture both from the soil and atmosphere. It is to be remembered by the cultivator, that this absorption of moisture from the air is as incessantly going on, as it is contained in it, abounding most when most needed by plants, that is, in the warmest and driest weather. This property possessed by the soil of absorbing moisture from the atmosphere, and the importance of increasing that power by pulverizing the soil, is not nearly so well understood as is desirable, although the farmer has the means of convincing himself of the fact by the most simple experiments. It is, indeed, an almost unfailing test of the comparative value of soils.*

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* "The power of the soil to absorb moisture from the atmosphere, depends, in a great measure, upon the state of division of its parts, the more divided they are, the greater being their absorbent powers. This property of soils is much connected with their fertility; when this power is great, the plant is supplied with moisture in dry seasons, and the effect of evaporation during the day being counteracted by the absorption of aqueous vapour from the atmosphere by the interior parts of the soil during the day, and both by the interior and exterior during the night. The stiff clays which take up the greatest quantity of water, when it is poured upon them in a fluid form, are not the soils which absorb most moisture from the atmosphere in dry weather; they cake, and present only a small surface to the air, and the vegetation is generally as much injured by drought on them as on sand. The soils which are most efficient in supplying the plant with water by atmospheric absorption, are those in which there is a due mixture of sand, *finely divided* clay and carbonate of lime, with some animal or vegetable matter, and which are so loose and light as to be easily permeable to the atmosphere. With respect to this quality, carbonate of lime, and animal and vegetable matter are of great use in soils, they give absorbent power to the soil, without giving it likewise tenacity: sand, which also destroys tenacity, on the contrary, gives it little absorbent power. I have compared the absorbent powers of many soils with respect to atmospheric moisture, and I have always found it greatest in the most fertile soils, so that it affords one method of judging of the productiveness of land."—*Davy's Agricultural Chemistry*, p. 182.

The depth of pulverization depends in some degree on the nature of the soil and subsoil. In rich clays it can scarcely be too deep, and even in sands, unless the subsoil contains some principle inimical to vegetation, deep comminution should be practised. The average depth may be from ten or twelve to fifteen inches.

A porous subsoil has been seen to contribute to the fertility of the soil, and the richest and most productive soils have, accordingly, always a subsoil pervious to moisture, which carries it off as it falls, by imbibing it or filtering it to a considerable depth below the active soil; so we ought artificially to make a complete drainage of subsoils, to produce the same effect, by having drains at short intervals, and by deep or subsoil ploughing across these drains, to draw off the water to them which falls on the surface, so that the active soil may be always kept so dry as to fit it for the purposes of vegetation.

Such are the reasonable advantages derivable from the due pulverization of the soil,—advantages which in most cases must be more or less easily within the reach of every cultivator. It possesses, too, the great advantage of improving land from its own resources. No other district need be impoverished; no expensive artificial fertilizers procured, to enable the farmer to render that portion of his land productive, which has been hitherto neglected. He has only to avail himself of the advantages which the improved construction of agricultural machinery now offers for his service.

The soil being the laboratory in which the food or nutriment of the plant is prepared, and the medium through which it is conveyed to the roots, it becomes a matter of primary importance to the gardener and agriculturist, to obtain correct ideas of its component parts, and the offices which they perform in the work of vegetation. In this respect, chemical research cannot fail to instruct, and rationally entertain, being the only sure guide which can be appealed to by the cultivator in cases of doubt; for the nature of earths and soils can never be properly understood, or scientifically ameliorated, until their components be discovered and calculated by means which cannot mislead.

Some slight proficiency in the analysis of soils is, indeed, a qualification which every scientific cultivator should endeavour to attain, and which he may do without much difficulty. In the first trials made by inexperienced persons, much precision of result is not to be expected. Difficulties will no doubt present themselves, but in overcoming them the most useful kind of practical knowledge will be obtained, and nothing is so instructive in experimental science as the detection of mistakes. The correct analyst ought to be well grounded in general chemical information, which is now comparatively easy to be obtained from any of the numerous elementary works on the subject; but, perhaps, there is no better mode of gaining it than by attempting original investigations. In pursuing his experiments, he will be continually obliged to learn from books the history of the substances he is employed or acting upon, and his theoretical ideas will be more valuable in being connected with practical operation, and acquired for the purpose of discovery.

But, however instructive original investigations may be, they will rarely be attempted by the mere tyro, and some proficiency must be attained in manipulations, which will be best effected by following the directions of some experienced chemist for conducting the process of analysis. As an example, we here quote those of Dr. Madden, communicated to the Highland and Agricultural Society of Scotland, as being simple, and well calculated to effect the object in view.*

For the chemical investigation of soil, a certain quantity is to be taken and mixed with seven or eight times its weight of pure water, and the whole raised to the boiling temperature. If any animal matter is present, which has already undergone partial decomposition, ammoniacal vapours will be given off, which may be detected, either by the smell, or by applying a glass rod dipped in muriatic acid† to the surface of the boiling liquid, in which case dense white fumes will be produced, owing to the union of the muriatic acid and ammonia, and the consequent formation of muriate of ammonia.‡ To explain this action, namely, the escape of ammonia when partially decomposed animal matter exists in the soil, we have only to remember, that one of the first changes which takes place during the decomposition of animal matter, is the union of its hydrogen and nitrogen so as to form ammonia, which, when formed, unites with various acids produced during the same process; and as these salts are very volatile, they escape with the aqueous vapour, and are decomposed by the muriatic, as already described. After boiling about ten minutes, the whole may be allowed to cool, and the earth to subside. The supernatant fluid is then to be evaporated to dryness, and the residuum weighed, which will denote the soluble matter. This, for obvious reasons, will amount only to a few per cent.*

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* See Prize Essays and Transactions, New Series, vol. xiii. pp. 160—163.

† Spirit of salt.

‡ Sal-ammoniac.

Another portion of the soil is next to be placed in a glass tube, closed at one end, and a quantity of a solution of caustic potassa poured over it, and the mixture boiled by the flame of a spirit lamp. If the soil be rich, a copious discharge of ammonia will take place, which may be detected as before, and the solution, on cooling, will be of an intense brown colour, which depends upon the fact that the organic matter of the soil, when only fitted for absorption, presents so far at least the characters of an acid† that it is soluble in alkalies, and forms with them a brown solution. In this experiment, therefore, all the organic matter present, which is fit for use, will be dissolved by the caustic potass, and hence the intensity of colour in the solution formed, may so far be taken as a criterion of the fitness of the soil for immediate culture.

To detect calcareous matter in the soil a small quantity may be placed in a glass tube, with a little pure water, and a few drops of muriatic acid poured on it. If the soil contains even one-fourth per cent. of chalk, it will be detected in this manner, by observing the bubbles of carbonic acid gas rising through the water.

The mechanical properties of the soil must also engage the attention of the experimentalist. For the purpose of ascertaining its texture, whether loose or adhesive, a portion of the soil is to be taken and placed in a coarse sieve, three or four inches deep, and water poured gently upon it until it commences to drop through. The soil is then to be dried to a temperature of about 70°, and if it be loose, on inverting the sieve the whole will fall out, and readily be broken down to powder; if it be cohesive, large clefts will be visible on the surface, and when removed from the sieve it will be in large masses, which will resist pulverization to a considerable extent. The time which it takes to dry may also be noted, provided the temperature be uniform, and in this manner some idea may be formed of the forc of attraction for water possessed by the soil.

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* Instead of evaporating and weighing the matter remaining, if the quantity of water used be four, in place of seven or eight times the weight of the soil, and the decanted fluid *a decided straw colour*, the operator may rest assured, that the specimen under examination is a rich soil.

† Hence the term *humic acid* which is commonly applied to it.

The depth of the soil is next to be noted, and afterwards the subsoil is to be placed under examination. The character of the subsoil should be particularly attended to, more especially if the land be horizontal, in which case it should always be porous, unless the soil itself be exceedingly loose. If, on the other hand, the land slopes away gradually and regularly, a retentive subsoil is not so dangerous. The chemical characters of the soil and subsoil should next be taken in *conjunction*, more especially if the soil be of bad quality, as it frequently happens that many of the evils arising from improper quality may be overcome by a due admixture of the two.

The method to be adopted for separating the sand and clay from each other, or at least for obtaining an index of their quantity, now remains to be noticed; and it may here be premised, that the greatest value to be derived from this is, that from the clay being by far the most frequent constituent of the impalpable powder, we by this means discover the proportion of this valuable ingredient. Let a quantity of soil be put in a long glass tube, which is afterwards to be nearly filled with water, and after being shaken, it is to be placed in an upright position to allow the particles of earth to subside. As the larger particles are of course the heaviest, they naturally fall first, and thus the whole mass arranges itself in layers, the impalpable powder forming the first layer, and being thus readily distinguished. Its proportion is ascertained by the relative space it occcupies in the tube, as compared with the coarser particles. This process is required only in sandy soil, and the very light clays, for in all stiff clays the whole soil is impalpable, and consequently no such separation takes place. We thus perceive that the examination of the soil is abundantly simple, and might readily be put in practice by every farmer. Nothing has been said about the detection of the saline constituents in the above remarks, as that requires too delicate manipulation to be attempted by the practical farmer.

II.—MANURES.

Cultivation has been seen to consist of two distinct objects, one of which comprehends the mechanical labours bestowed upon the soil, and the other the chemical application of manures. By the latter term are understood all those matters which, when incorporated with the soil, tend to increase its fertility.

The productive powers of nature appear never to diminish: the process of vegetation goes on year after year, with increasing energy, and brings forth an increase of vegetable matter, to be again decomposed and returned to the soil; and this is the natural process by which the decomposing vegetable matter which we find in the soil is formed. Thus the growth and decay of vegetable matter go on in a continual succession, and the decomposed remains of one crop become nourishment for the next.

The substances capable of being used as manures are numerous, and are very different in their nature and properties. On account of the changes that are continually taking place in nature a variety of matters are unfolded, elaborated and prepared for the nourishment and support of vegetables; and an object in the application of manures is to facilitate the changes which produce these results. The substances applied as manures may consist of animal and vegetable matters alone, or of a combination of these with earthy matters in different proportions; or they may consist of mineral matters alone. These include the dung of the farmyard, the mineral manures commonly applied, as lime, marl, and gypsum, and the various combinations of these with other matters. They may therefore be classed, according to their origin, into—

1. Organic manures, or those of animal and vegetable origin.
2. Inorganic manures, or those derived from mineral substances.
3. Mixed manures, or such as are derived partly from organic and partly from inorganic matters.

In describing these substances it is not intended to enter into any disquisition concerning their chemical mode of action—not because it would be useless or unprofitable—but it would be foreign to the nature of the present publication ; nor is it essential to the acquisition of that practical knowledge of the subject which will suffice for the common purposes of the farmer. He, however, who applies a peculiar species of manure which has been found beneficial to his ground, being himself ignorant of chemistry, only follows the practices to which he has been accustomed ; and while he sneers at the theorist who would direct his attention to the principles of his art, both he and those whom he follows are probably originally indebted for that practice to the observations of men of science.

I.—ORGANIC MANURES.

The analysis of vegetables shows us that all the products of plants are resolvable into a very small number of elementary bodies, existing in various states of combination. These are carbon, oxygen, hydrogen, and, in certain plants, nitrogen or azote. Certain mineral substances are also found in plants, but they exist only in small quantities, and some of them are in certain cases altogether wanting. The simple bodies enumerated may therefore be regarded as forming the essential constituents of all vegetable substances.

But these bodies form the elements of animal as well as of vegetable substances, both being ultimately resolvable into carbon, oxygen, hydrogen, and nitrogen. All animal and vegetable matters, therefore, form food for plants after being reduced to that state in which they can be absorbed by the roots.

The simple bodies which form the substance of organic manures exist in various states of combination, and it has been ascertained by experiments, that the solid matters formed by these simple bodies must be soluble in water before they can become available for the nourishment of plants. This arises from the minuteness of the pores by which the nutriment is absorbed. In order, therefore, that the manures applied to the soil may exist in the state best calculated to effect the object in view in their application, it is necessary that they should be in a certain degree soluble in water, otherwise their action will be chiefly confined to the improvement of the texture of the soil, instead of affording direct nourishment to the growing crop.

Water is the fluid existing in the soil in which these matters must be dissolved; but organic matters in general are very sparingly soluble in water, and they must undergo certain changes, either in the soil or before being applied to it, to increase their solubility. These are found to be produced by the process of fermentation, during which the elements of organized matter have a tendency to separate from each other and form new compounds, which are immediately available as food for the growing plants. Certain substances are also disengaged in the process of fermentation, which are calculated to act in improving the texture of the soil, so that it is advantageous that it should take place in the soil; and this is the case in practice, the fermentative process being completed, after the substance to be used as manure is mixed with the matter of the soil; but it is common also to make it undergo a certain degree of fermentation previous to its application.

The method of preparing this class of manures upon the farm, then, consists in making them undergo a certain degree of previous fermentation. This must in all cases be carried so far that it will be completed after the manure has been mixed with the soil; and as decomposition takes place much more quickly in the case of certain organic substances than in others, the degree of previous fermentation is to be regulated by the nature of the substance to be applied.

Animal and vegetable matters, when the principle of life has departed from them, begin spontaneously to be decomposed. The elements which enter into their composition, when left entirely to the disposal of their chemical affinities, have a tendency to separate from each other; and this goes on most rapidly when they are exposed to the air, kept moist, and preserved at a degree of warmth higher than the usual temperature of the atmosphere. Putrefaction is retarded, or almost prevented, when the fermenting substances are dried, so that their own moisture is expelled, carefully excluded from air and moisture, and kept cold. The influence of heat, in promoting the decay of organic matter, depends upon the repulsive power it possesses, by which it disposes the various elements to assume the gaseous form. Animals and vegetables are frequently found in snow or ice in a high state of preservation.

Such are the changes which go on in all organized structures. That mysterious agent *life* is able, by its peculiar power, to control and overcome the chemical attractions which tend to produce these changes, and retains these elements in that state of combination best adapted for the performance of their proper functions ; at the moment, however, in which life ceases to superintend the exercise of these functions they cease, and the chemical attractions, no longer restrained by the vital principle, obtain full sway. The carbon, oxygen, hydrogen, and nitrogen, formerly existing in combination, obey the laws of chemistry, mix with the earth and atmosphere, afford nutriment to a new race of beings, again wither and decay, and return to the soil to supply new generations.

During the process of fermentation a great proportion of the elementary parts of the substances fermented makes its escape in various forms of gaseous combination, and as the substances thus escaping are those readily available as food for the growing plants, it is advantageous that the process should take place in the soil to as great an extent as possible, in order that they may be retained in the soil. Certain organic substances, however, are difficult of decomposition, and were they applied to the soil in their fresh state, they would remain undecomposed for a length of time, and the object in view in their application would not be attained. Hence, the necessity of making the different species of organic matters, applied to the soil as manure, undergo such a previous degree of fermentation as will insure the completion of the process after its application to the land.

This tendency to spontaneous decomposition is much greater in the case of animal matters than in that of vegetable, and there is consequently less necessity for their being previously fermented to a certain degree. Yet even in the case of those substances, decomposition to a certain extent may be advantageous. Thus it is found, that urine in its recent state does not act so beneficially as a manure, as after having undergone the fermentative process. But it is to be remembered, that the chief advantage derived from the fermentation of animal substances is the facility with which they bring on the decomposition of vegetable matters, by being incorporated with them.

When green and succulent vegetable substances are acted upon by the atmosphere, decomposition also readily takes place without any admixture of animal matter; but after being dried, as in the case of straw and other litter, they are difficult of decomposition, and in order to hasten the process, a mixture of animal or succulent vegetable matter becomes necessary.

Straw of all kinds, or similar dry vegetable matter, when used as litter, is well known to form a principal ingredient in the composition of farmyard manure, and is found valuable, not so much perhaps from the nourishment which it is of itself capable of imparting to the soil, as from the value which it acquires from the absorption of urine, as well as by combining with dung, in its different stages of decomposition, and imparting consistence to the mass of manure, which is thereby carried more regularly through the process of fermentation. Nothing, in fact, can be better adapted for the mixture than straw: for it would rot with difficulty but for the dung, and there can be no doubt this combination forms the most valuable kind of manure. All the various sorts of straw and haulm answer the purpose of litter. When these are scarce, many other substances are substituted, and the quality is but little regarded, because, being seldom employed except in cases of necessity, they do not admit of choice. But besides being used as litter, vegetables may be advantageously used as manure alone. Thus all kinds of green vegetable productions may be employed in this way, such as the luxuriant weeds of rivers, lakes, and ponds, and the refuse of the different kinds of vegetables of the garden as well as the farm. When materials of this description are to be employed as manure, they should be cut down in their green state, either before or during the period of flowering, in order that they may be in the most suitable condition for becoming quickly decomposed, and to prevent the loss of the succulent matter sustained by the formation of their seeds, as well as the danger of their afterwards vegetating in the soil.

The properties of farmyard dung depend, in a certain degree, on the kind of animals fed, and the nature of their food. When the dung of horses is sufficiently moist and exposed to the air, it quickly enters into a state of fermentation, which if the manure be loosely heaped together, will become so violent as to give the whole a mouldy appearance, and deprive it of much of its fertilizing powers. If it be laid upon land before being entirely decomposed, its effects upon vegetation are prompt and powerful; and this is partly to be attributed to the heat which is developed anew, when, after being mixed with the soil, its decomposition is completed. This occasions it to act with singular efficacy upon lands which are cold and clayey, the faults of which it tends greatly to correct, and the soil is much benefited by the application.

The dung of cattle also soon ferments when it is collected into a heap, and merely moistened by its own humidity, but much slower than that of horses. Whatever may be the degree of fermentation at which it has arrived, it does not seem to occasion any perceptible heat in the soil, and it is consequently best adapted to dry, warm soils. Thus upon sands and gravels, which are naturally hot, its cooling qualities counteract that effect, and upon such lands it has accordingly been found of great service.

The urine of the animals of the farm forms a very valuable addition to the stock of manure of the farmyard, as it not only tends to hasten the decomposition of other matters, but it is also a very valuable manure in itself, containing in combination all the elements which enter into the composition of plants. Urine is efficacious, whether applied in a recent or fermented state, but experience has shown, that after having undergone a certain degree of fermentation, its fertilizing effects are increased.

But the urine is liable to be wasted in flowing from the feeding houses, unless arrangements be made for its retention. Conduits leading from the different houses and yards to a reservoir placed in a convenient situation, would collect a much larger quantity of liquid manure than could be readily conceived. If drains were formed, all the excess of moisture only, which could not be absorbed by the straw, would run into them; so there is no danger of making the farmyard manure too dry by means of these drains. That excess which is thus economically collected, is preserved from evaporation, or oozing from the dunghill when taken from the yards, before the manure can be prepared for application to the soil. Instead of being lost, could it be applied in any manner beneficially to the land, more produce would be raised by it on the farm, while, at the same time, much more comfort would be ensured to the live-stock of the farm.

The liquid manure thus obtained is spread over the manure heap, if there be any deficiency of moisture, to hasten the process of fermentation, or it may at once be taken to the fields and spread upon the land. When applied to grass lands it is found to increase the produce in a great proportion, but it is not applied with equal advantage to the other cultivated crops.

A great advantage which arises from manuring with urine, consists in the quicker return effected on the capital of manure, in consequence of its being applied to plants already in a growing state. In the case of manuring with solid excrements, a period of two or three years may elapse before complete decomposition ensues, and the plants have derived the full advantage. The crops, too, during this period, lose much of the manure in consequence of its best portions being drained away by rains; but when urine is employed as manure, its salts and other fertilizing elements are consumed by the plants in a few months.

A certain degree of fermentation in the manure, previous to its being applied to the soil, is seen to be essential in all cases, but to what extent this fermentation should proceed is not so easily determined. In general, clay soils, more tenacious of moisture, and more benefited by being rendered incohesive and porous, may receive manure less decomposed than well-pulverized soils of the lighter class require. Some plants, too, seem to thrive better with fresh dung than others, potatoes in particular; but all the small-seeded plants, such as turnips, clovers, and carrots, which are extremely tender during the first stages of their growth, require to be pushed forward into luxuriant vegetation, with the least possible delay, by means of well-decomposed manure. The season at which the manure is applied to the land is also a material circumstance. In spring or summer, whether it be used for grain or green crops, the object is to produce an immediate effect; and the manure should, therefore, be more completely decomposed than may be necessary when it is laid on in autumn, for a crop whose condition will be almost stationary for several months. In short, it appears that the degree of fermentation at which farmyard manure should arrive, must depend on the texture of the soil, the nature of the plants to which it is applied, and the time of its application.

In the process of putrefactive fermentation, the elements of the body fermented, in assuming their new forms of combination, partly make their escape in the gaseous state. In the fermentation of manures, the decomposition may proceed so far, that the great mass of the substance shall be exhaled, leaving behind only the earthy and alkaline, and a portion of the carbonaceous matter of which it was composed. In this case, a considerable portion of the more valuable parts of the manure are dissipated; and, in order to guard against the waste thus occasioned by fermentation, it has been recommended to apply those manures to the land in their recent state, before fermentation has taken place. This is, however, directly at variance with the practice of the best farmers. Experience has confirmed the practice of allowing the manure to undergo a certain degree of previous fermentation; but the process should neither be continued longer, nor carried to a greater degree, than is necessary for the purpose intended.*

In order to know when dung is sufficiently fermented for the particular use required, a very little practice and observation will suffice. When it is fully fermented, the long stems of straw which formerly matted it together, are in such a state of decomposition, that the parts can be readily separated by a fork. It is not necessary, in any case, that it be in that extreme state of decay in which we often see it used by gardeners, and when it can be cut by the spade like soft earth. Whenever farmyard dung has been fermented to this degree, it has been kept beyond the proper time, and the management has been bad.

The stock of manure is allowed to accumulate in the yards during the winter and spring months; or it is conveyed at intervals to the field to which it is to be applied, there often to be mixed with other materials, and undergo a further degree of fermentation. The latter is the more convenient practice; for, although there is a certain waste of the volatile parts of the manure by this management, yet it is frequently convenient in practice, that it should be thus carried to the field where it is to be used, so as to economize time at the season of more active labour.

A sheltered situation is accordingly chosen in the field to be manured, and the manure is conveyed to it as occasion offers, or when the state of the weather prevents the other labours of the farm from being carried on. The height of the heap need not exceed five or six feet, and the breadth should be sufficient to admit of two carts being loaded at a time. It will be found a considerable saving of labour to form the top of the heap in a slanting direction, with one end so low as to admit the horses to go up and unload upon it. It is to be continued in this manner until it is nearly finished, when the end at which the carts entered is to be made up as the other. If a considerable time is to elapse before the manure is to be applied to the land, the sides of the heap should be made up with earth, and the top covered over with the same material. The treading of the horses, and consequent consolidation of the heap, and the covering of earth, will prevent the fermentative process from taking place until it is desirable that it should do so. When it is wanted to take place immediately after the formation of the heap, it is better that it should not be compressed by unloading upon it, and the covering of earth may be omitted.

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* Elements of Practical Agriculture, p. 46.

As the time approaches for the application of the manure to the land, a complete turning is to be given to the heap. In this operation, the workmen begin at one end, and, taking off a portion of it, turn it over, laying that which was before uppermost underneath, and proceeding in this manner until the whole is turned. No treading of cattle, or compression of any kind, should take place after turning; for the looser the materials are put together, the more rapidly will fermentation proceed, owing to the free access of air which is then admitted. When the manure is preserved in yards until it is to be deposited in the ground, it is also to be turned over in the manner described, before being applied to the land.

Where the dung produced is rich and well-decomposed, as when cattle have been feeding in stalls on juicy and nutritive food, it may not appear to require this turning over to fit it for use; yet, even in such a case, it is generally beneficial that it be turned over at least once before being used, the effect being to ferment the mass not only sufficiently but equally, and to mix its different parts together. It may be observed also, that when the mass of animal and vegetable substances is thrown into a common yard, some care should be bestowed in spreading it equally, so that one part of the yard may not be filled with rich dung, and another with poor. The dung of horses, for example, is more susceptible of quick fermentation than that of cattle; and when the stable, therefore, opens upon a common yard, the horse dung should not be allowed to accumulate about the stable, but spread abroad upon the general heap. In the removal of manure from the yards to a heap in the field, the like precautions are to be taken, in order that the different sorts may be thoroughly incorporated together.

The dung of the farmyard derives its chief value from the animal matters which it contains, which often form only a small proportion of the manure; and the value of a great part of the manures applied to the land must depend on their effects on the texture of the soil. Even in the case of purely animal matters, the proportion consumed as the food of plants is very small, the excrements of cattle containing, in their fresh state, upwards of eighty per cent. of water, and those of horses about ten per cent. more. The remaining part is found to contain those gaseous substances of which plants are composed, with the salts of lime, potash, and soda, which are also present in small quantities in vegetables. The peculiar action, then, of these organic manures depends, in a much greater degree than is commonly supposed, on their inorganic constituents, which thus restore to the soil that which is removed in the form of roots and grain. It is quite certain that the vegetable constituents of the excrements are not entirely without influence on the growing crops, for they will decay, and thus furnish carbonic acid to the young plants; but it cannot be imagined that their influence is very great, when it is considered that they are applied only once in five or six years, or sometimes even longer. When we manure land with the dung of the cow or the sheep, we supply it with silicate of potash and some salts of phosphoric acid. In human fæces we give it the phosphates of lime and magnesia; and in those of the horse, phosphate of magnesia and silicate of potash. In the straw which has served as litter we add a further quantity of silicate of potash and phosphates, which, if the straw be putrified, are in exactly the same condition in which they were before being assimilated.

It is evident, therefore, that the soil will alter but little, if we collect and distribute the dung carefully; a certain portion of the phosphates, however, must be lost every year, being removed from the land with the crops, which are again to be supplied by succeeding applications. We could keep our fields in a constant state of fertility by replacing every year as much as we remove from them in the form of produce; but an increase of fertility, and consequent increase of crop, can only be obtained when we add more to them than we take away. From the foregoing remarks, however, it will readily be inferred, that for animal excrements, other substances possessing their essential constituents may be substituted.

The produce of the farmyard will necessarily afford the chief part of the manure consumed upon farms which do not possess extraneous sources of supply. But besides the produce of the farmyard, there are certain other organic substances which may be applied to the manuring of land; such as bones, ashes, soot, the refuse of various manufactories, sea-weed, and several other matters.

Bones form a very important animal manure. Although of comparatively late introduction, they have occupied much of the attention of farmers, and their use is gradually extending. On all light soils, indeed, they form a very valuable manure. In addition to their fertilizing properties, they have the great advantage of being easily procured, and their extreme portability facilitates their conveyance from one place to another. They are also capable of being preserved for a long time when kept dry.

The analysis of bones, in the absence of any other evidence, would justify their application as a manure. Bone is known to consist of earthy and animal matter in nearly equal proportions, but varying according to the age and condition of the animal. The animal matter in the bone is constituted almost entirely of the same elements as those which enter into the composition of plants, and every portion of it, sooner or later, is liable to be dissolved and absorbed by their roots. The earthy part of the bones consists of lime, in combination with the phosphoric and carbonic acids, both of which compounds are highly valuable manures. Unlike any other substance employed for the purpose, every particle of the bones is calculated to have a beneficial effect; either indirectly, by acting on substances previously contained in the soil, or directly, as providing those matters which are known to enter into and support the growing plant.

Bones are less beneficial when applied to clay lands than to the lighter soils, and in wet seasons than in dry. Although the quantity employed is comparatively small, it is not quickly exhausted, but extends its influence to future seasons.

The bones, before being applied to the soil, are reduced to small pieces, approaching to a coarse powder. The size to which they should be broken is of importance to determine, as the smaller the size, the more prompt and powerful will be their effects. They are most efficacious, so far as regards the crop to which they are applied, when reduced to a powder; but their effects in this case are not durable, being almost confined to a single crop. It is better, therefore, that a part of the bones should be powdered, and the other part of a larger size, as the powdered bones will then accelerate the growth of the crop to which they are applied, and the effects of the larger ones will be perceptible for a number of years.

In common with all organic substances, bones readily ferment when placed in a heap to which air and moisture have access; and it is a very general opinion, that they are more valuable as a manure after they have undergone a certain degree of fermentation. They are then in a decomposing state, and are fitted to act more immediately on the growing plant. This has led to the formation of composts of bones and various earthy and organic matters; but although the previous fermentation of bones may increase their power on the actual crop, it will be proportionally diminished on the succeeding ones.

Bones may be applied to the land either by the hand or machinery. When used only in small quantities they are generally deposited by the hand, and this method is found to be at once economical and expeditious. The crop to which they are applied with greatest advantage is the turnip, and so well suited are bones as a manure for that plant, that larger crops are produced by it than by any other species of manuring. Unlike every other manure, an application beyond a certain quantity is not found to produce a corresponding effect on the crop, and hence small quantities have often been applied with as great success as large. The usual quantity is from twenty to thirty bushels to the acre.*

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* "Bones may be regarded as composed of earthy and saline matter, cartilage and jelly, and fatty matter—all existing in relative proportions so variable, that no relative quantities can be assigned. The quantity of earthy matter varies according to the age of the animal; and, in like manner, the quantity of fatty matter depends on the condition of the animal too. In the best kind of bones for

Ashes of different kinds are also used as a manure. Their constitution will of course vary with the nature of the substances from which they are derived. When any vegetable substance is burned, the whole of the oxygen, hydrogen, and nitrogen, which it contained, is

manure, those from fat, young animals, perhaps the following proportions may give an approximation to the relative quantities of each in 100 parts :—

Earthy and saline matter, ...	40
Cartilage and jelly, ...	40
Fatty matter, ...	20
	100

"We shall now inquire how much of these substances may be available for the food of plants ; and in the first place, without even inquiring into their composition, we may exclude such parts as appear to remain for a number of years completely insoluble. In seeking for such, we naturally look first to the earthy matter, and we find that it is composed of lime in two portions united to two acids. Of these earthy compounds, that which exists in by far the greatest quantity is phosphate of lime, a substance so very indestructible that bones are still found, having their earthy texture entire, which are ascribed by many to an era anterior to the Deluge. It presented indeed, to the early chemists, an aspect so very averse to decomposition, that they were induced to name it the *earth of bones*, as if it were a simple substance ; and even now, though its composition is fully known, it is sometimes still called by this name. The other earthy ingredient, which seems to vary from four to ten per cent. of the whole earthy matter, is carbonate of lime. The former of these, then, we must reject, as of too indestructible a nature to yield any manure to the soil, even when surrounded by moisture, and the roots of growing vegetables—a combination of circumstances which we believe to exert decomposing influences of greater power than those of inorganic chemistry ; and the latter, the chemical composition of which is the same as common limestone, though in the circumstance in which we have mentioned it to be slowly soluble, exists otherwise in all fertile soils in such quantities that it need not be regarded.

"In seeking then to account for the action of ground bones upon the plants and the soil, we must entirely inquire into the other constituents, while we may regard those which have been described as so many earthenware vessels in which the valuable substances are contained. The soft parts of the bone, which we have supposed to form in the best bone sixty per cent., and which may, perhaps, on an average, amount to fifty per cent., are composed of jelly, fatty matter, and cartilage, which are almost entirely constituted of the same elements as plants, and all of them, sooner or later, and probably in the order in which they have been now enumerated, liable to be dissolved and absorbed by the roots. The dissipated, together with a greater or less proportion of the carbon, according to the degree of exposure to the atmosphere during combustion. Ashes are consequently composed of all the fixed saline ingredients of the substances consumed with more or less of carbon, yet their effects as a manure are not very great. Sometimes, how-

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cartilage, indeed, when the bones have been buried in a dry situation, is very indestructible; for though it does not exist in those supposed antediluvian bones which have been referred to, yet it has been found in bones of undoubtedly great antiquity; but when exposed to the action of air, water, soil, and vegetation, it will pass into the state of jelly, and be dissolved or otherwise decomposed, probably at the time when the gelatine and oil, the decomposition of which begins almost immediately, shall have been nearly exhausted.

"Any attempt that could be made to assign the exact quantities of the different elements which constitute the soft parts of bone, would necessarily be very imperfect; because the fatty matter differs considerably in composition from the other ingredients, and its quantity will be very different in different bones, and be affected, too, by the processes of cookery, or of exposure and maceration, to which the bones have been subjected since the death of the animal. The following, however, may be taken as an approximation to the constituents of 100 parts:—

Carbon,	55
Oxygen,	25
Hydrogen,	10
Azote,	10
	100

"Were we, in the same way, to form a rough guess at the average composition of vegetables, exclusive of earth and salts, which vary from one to two per cent., in the green plant, we should have as an approximation to the composition of 100 parts:—

Carbon,	50
Oxygen,	44
Hydrogen,	6
Usually a little Azote.	
	100

"From these calculations and analysis, it appears that probably half the weight of the bones which we apply to the soil is calculated to be entirely consumed by plants as their elementary food, while the lime of which the remainder is composed will be gradually absorbed; for lime, in greater or less quantity, is always present in vegetable structures."—*Quarterly Journal of Agriculture*, vol. i. pp. 49-51.

ever, they possess a peculiar value, as in the case of Dutch ashes, derived from their mineral constituents. They should be kept dry until applied to the land, and the sooner the application takes place they are the more efficacious. They are spread upon the surface of growing crops of different kinds, but they are in general attended by more beneficial effects when spread upon young clovers than in any other case.

Soot is also, in its unmixed state, frequently applied as a manure. Like ashes it is advantageously spread upon grass land, and is occasionally used as a top-dressing for wheat. One of its most common uses among farmers, however, is for turnips, either sown along with the seed, or, more usually, immediately after the plants appear above ground, as it is so acrid and bitter as to prove injurious to insects, and has accordingly been found useful in reventing the ravages of the fly and wire-worm.

The refuse in the manufacture of soap, termed soapers' waste, has been much recommended as a manure. It varies in its properties, according to the qualities of the alkali employed, and the kind of soap manufactured: that produced in the manufacture of hard soap being far superior to the waste from soft, arising from the substitution of potash for barilla in the manufacture of the latter.

On strong cold soils, and on peaty soils and other land rank with vegetation, soapers' waste is found to be highly beneficial: on loams it is also an admirable manure; but its application is not advisable on calcareous soils. It is well calculated for grass lands. The quantity used may be about eighty bushels to the acre: but much larger quantities have been used, especially of the refuse from soft soap. Autumn is the best season for applying it to grass lands. For arable lands the quantity should be increased, and it ought to be greater upon strong soils, and upon peat, than upon light loams.

Sea-weed, consisting of different species of *fuci*, and other marine plants, is also generally used along the sea-coast as a manure. In these situations it is a very important source of fertility to the soil; and, when used with judgment, never fails to enrich the coast land of every district in which it can be procured. Its effects are by no means so durable as farmyard dung, lasting only for one or two crops. When applied to arable land, it should be immediately spread and ploughed down after it is secured, being then greatly more efficacious than after being exposed for some time to the weather. When it cannot be applied in its recent state, it should, therefore, be formed into a compost with dung, or a mixture of dung and earth. When spread upon land in pasture, it improves the quality and increases the quantity of the herbage. It is more valuable for light and dry soils, and of less comparative value for the stiffer clays. On arable land there is no certain rule for the quantity which may be applied, as it may be used to any moderate extent without injury. The quantity is usually one-half or one-third greater than that of farmyard dung.

Night soil is a very important animal manure. It is not only quicker in its operation than any other, but supplies a greater abundance of vegetable food. Its disagreeable smell may be removed by mixing it with ashes or quicklime; and on being exposed to the atmosphere it soon dries, and, it is afterwards easily pulverized. It then becomes portable, and all unpleasantness of smell being removed, it is packed up in barrels in the metropolis, and frequently conveyed to considerable distances. The crops to which it is applied are always luxuriant the first year, but afterwards there does not appear to be any difference between the effects produced by it, and those produced by farmyard dung. It is applied in small quantities.

In addition to the bones and excrement of animals, their flesh and intestines are sometimes used as manure with good effect. The largest quantity of this species of manure is furnished by the refuse of shambles, but were advantage taken of appropriating such matters of this description as may be collected about the farmyard, and the remains of animals which die from accident or disease, a large addition might be made to the stock of manure upon the farm, and substances which are offensive when exposed, be converted into a source of profit. Such matters undergo a rapid decomposition when exposed to the influence of the atmosphere, and to prevent the escape of their volatile particles, they should be covered with earth, which they will soon impregnate with fertilizing matter, which will thus be retained, to be afterwards applied as manure. As in the case of night soil, the disagreeable effluvia from such substances may be removed by quicklime being spread over them.

II.—INORGANIC MANURES.

The substances of which we now come to treat act in a manner totally distinct from organic manures. They cannot be, from their nature, capable of supplying either of the four elements, carbon, oxygen, hydrogen, or nitrogen, which, as has been already stated, form the essential constitution of all plants. We must therefore look to other circumstances besides the mere nutrition of vegetables, in order to explain the true cause of those beneficial effects which, beyond doubt, result from their judicious application.

The advantages to be gained by the use of inorganic or mineral manures may obviously be either direct or indirect, according to the effect which they produce. They may act upon the soil by improving its texture, or by rendering soluble the parts of it which are insoluble; or by otherwise fitting it to promote the growth of plants; and in this case it may be said, that their mode of action is *indirect* in forwarding the growth of plants. But they may act immediately upon the plant itself, by being received into its substance, and then they exert a *direct* influence in the process of vegetable nutrition.

The manner in which this action takes place upon the organs of the plant, may elude our observation; but this much may be admitted, that certain earths, oxides, and alkalies, or combinations of these with acids, pass into the substance of the plant, absorbed it may be in part from the atmosphere, but chiefly, along with the aqueous portion of the sap, from the earth in which the roots are fixed. Some substances, taken up in this latter mode, are known to act as poisons, while others exercise a beneficial action upon the plant.

We cannot generally distinguish when a mineral substance acts upon the plant through the medium of a change in the soil, or when it acts directly upon the plant itself. All that we truly know is, that certain earthy and alkaline bodies, or their saline combinations, applied to the soil, promote the growth of plants, and so, in the language of farmers, are manures.*

Lime is applied with a view of rendering whatever substances may be contained in the soil, or matter which forms part of it, more suited for promoting the growth of plants, and of counteracting the effects of noxious substances, and rendering them either harmless or useful. With the aid of a sufficient degree of moisture, lime rapidly decomposes all animal and vegetable substances; and when spread upon land covered with heath or moss, the old turf is decomposed, and a saponaceous compound is formed, which sinks into the soil, and tends to favour the production of sweet and abundant herbage. It is also well ascertained, that it imparts a certain degree of vigour to some peculiar plants, and enters in various proportions into their composition,—a fact ascertained by chemical analysis.

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* Elements of Practical Agriculture, pp. 59, 60.

Lime acts with peculiar efficacy upon land which has been previously either more or less manured with animal or vegetable substances, without any addition of calcareous matter. In this case, it often produces effects much more nourishing and durable than the application of dung, for its active powers render every particle of the putrescent manure useful. In all arable land, however impoverished it may be either by nature or bad management, there exist some portions of the remains of organic matters; and, accordingly, the first dressing of lime occasions a sensible improvement in the soil, which soon becomes apparent in its increased produce. A second application will also be attended by some apparently good effects; but unless that, and every succeeding application, be accompanied by ample additions of organic manure, to supply the waste thus produced, every future crop will be diminished in value, and the land become deteriorated in condition. It is then necessarily thrown out of cultivation, and left for a series of years to recover itself in pasture, which, in the course of time, will be effected; but in the interim it is rendered nearly worthless.

That the land becomes exhausted by repeated applications of lime followed by severe cropping, has been proved beyond the possibility of doubt. It is evident that the continuation of cropping, without an addition of nutritive matter, will ultimately exhaust the best soils. The active powers of the lime will make the land produce crops so long as there is the smallest portion of nutritive matter in its composition, after which its fertility cannot be restored without liberal applications of organic manures. The state of the soil should therefore be minutely examined into before lime is applied; and it should only be used to give effect to the inert substances with which it may be combined.

Lime may be advantageously applied to any soil in which there does not already exist a sufficient quantity of calcareous matter. Its employment seems to be of the greatest service in the breaking up of fresh and coarse land, on which it acts more powerfully than on soils long under cultivation. The most striking improvements have been effected by means of it on moor land and mountain. Whenever it is found advisable to deepen the soil, by ploughing up a portion of the subsoil, the application of lime is the most speedy means presented to us of correcting the defects of the substances newly exposed.

When lime in its pure state, in which it is called quicklime, is exposed to the atmosphere, it has a tendency to return to its original state of carbonate. In undergoing this change it first absorbs a large quantity of water, and then assumes the form of slaked lime, or, according to chemical nomenclature, has become a *hydrate.* This hydrate, in its turn, rapidly absorbs carbonic acid, and thus in a short time the lime returns to its original state, the only difference being in the mechanical arrangement of its parts. In this state it is termed *mild lime* by the farmer. Its powers are more or less energetic according to the state in which it is applied, but the usual form of application is that of a hydrate, as, in addition to its greater stimulating powers, it may then be spread more equally on the surface, and better incorporated with the matter of the soil. When it is merely intended, however, to supply calcareous matter, it often seems to be unimportant in what state it may be applied.

The most important object gained from the use of quicklime seems to be the decomposition of woody fibre, and the consequent formation of various soluble compounds, which are not themselves readily soluble until after a considerable time, thus performing two functions apparently opposed to each other.

Lime forms these insoluble compounds with almost all the soft animal and vegetable substances with which it can combine; but these compounds, exposed to the combined action of the air and water, are altered in time; the lime gradually becomes a carbonate, then animal or vegetable matters are by degrees decomposed, and furnish new compounds capable of nourishing plants; so that lime, in performing two functions seemingly opposed to each other, really promotes the fertility of the soil and the growth of plants. It first disposes certain substances insoluble in water to become soluble, while, by combining in part with substances which are soluble, it prolongs the nutritive action of soft animal and vegetable substances beyond the time in which they would have acted, if they had not entered into a combination with lime.*

The application of lime to the soil in its caustic state will be useful in all cases where there is an excess of undecomposed vegetable fibre, as in all places in which the natural growth has not been interfered with for a number of years. The undecomposed matter of these it tends to decompose, and renders the soil capable of supporting the more valuable plants.†

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* "Of this particular mode of action of lime, an example may be given in one of the arts. When it is wished to carry off from the vegetable juices, in the manufacture of sugar, the animal substances which have been used, lime is employed, which combines with these substances, and rises with them to the surface of the liquid in the form of a thick scum, which is insoluble in water. This scum, laid upon the fields, is injurious to plants; but when it is deposited in a ditch, and is allowed to ferment for a year, it forms one of the richest manures. Count Chaptal states, that he has proved this fact, during a period of many years in his manufacture of sugar from beet-root, by employing in this manner the scum which is obtained by the first operation which is performed on the juice of the beet."—*Elements of Practical Agriculture, &c.*

† "It is well known that the more valuable plants require a richer food than those which are less valuable, the remark being the more striking the lower we descend in the scale of vegetables. The more worthless the plant, the more easily is it nourished by the atmosphere; and hence the less is it dependant on the soil for its subsistence. The consequence of this is, that when, in the lapse of time, the soil of any spot becomes more and more exhausted, the most valuable herbage gradually dies away from the want of sufficient nourishment, and gives place to those diminutive species which so frequently constitute the herbage of barren moors. These again, if moisture be present, give place in their turn to the mosses and other inferior plants, so that at last, unless the improving hand of man steps in to avert the doom, the spot will return to a state unfit for the support of vegetation, with the exception of those inferior vegetables which derive their chief support from the atmosphere. From the looseness of the texture of such plants the application of hot lime in such a case converts them into useful manure, which by being washed into the soil by genial showers, revives the seeds of those plants which grew there ages previously, and in a short time the lately unprofitable waste glows with the return of its pristine verdure. Hence the tendency of lime to destroy the inferior classes of vegetables, and supply their place with the more valuable plants."—*See Quarterly Journal of Agriculture*, vol. x. p. 92.

Lime may be applied to the land in various ways, and at different periods:—

1. It may be laid on the surface of land which is in grass, and remain there until the land is ploughed up for tillage. The lime, in this case, quickly sinks into the soil, and acting upon it, prepares it for crops when it is again tilled.

2. It may be spread upon the surface while plants are growing, and the tillage given to the crop sufficiently incorporates the lime with the soil.

3. It may be, and most frequently is, applied during the season in which the land is in fallow, or in preparation for what are termed fallow crops. The manner of applying it in these cases will be afterwards explained.

4. It may be mixed with earthy matters, particularly with those containing vegetable remains, and in this case it forms a compost. It should not, however, be mixed with animal substances, unless for the purpose of correcting noxious effluvia. It is injurious when mixed with common dung, as it tends to render the extractive matter insoluble.*

The quantity of lime to be applied must depend on the nature of the soil and its state with regard to cultivation. Stiff clays require a larger proportion of it than the lighter soils; and in the case of such soils as contain much undecomposed vegetable matter, as peat, a quantity should be applied sufficient to decompose the inert fibre effectually.

On heavy soils, one hundred bushels of newly calcined limestone to the acre may be considered a moderate dose, and on those of a lighter description, eighty or ninety bushels. Double these quantities of slacked lime is to be employed, in consequence of the increase of bulk which takes place during the operation of slacking. The observations already made on the nature and properties of this manure, and its mode of action, will enable the farmer to ascertain, with tolerable precision, the proper quantity suited to his particular case.

The quality of the lime itself should be taken into consideration, as well as the nature of the soil, in determining the precise quantity which should be applied. Lime is rarely found in a pure state, being generally found in combination with other matters; and when these exist in quantity, the amount of lime must be increased in order to produce the intended effect. When combined with silica or alumina, for example, the quantity to be applied must be increased in direct proportion to the bulk of these ingredients which it contains; for although they do not impart any deleterious principle to the soil, yet they are inefficacious so far as the object in applying the lime is concerned.

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* Elements of Practical Agriculture, pp. 63—4.

A simple test for ascertaining the quality of the lime consists in noting the decrease in weight after calcination, and the increase of volume after slacking. We have seen that limestone is a combination of lime and carbonic acid, and as the acid is driven off by heat, it is evident that the decrease in weight after burning will be a tolerably accurate test of the value of the lime. And as the application of water to newly-calcined lime converts it into a hydrate, the operation being attended by an increase of bulk, it follows that the increase of volume will also be a fair criterion of value; for the purer the lime the more will it expand after being slacked.

If these tests are not considered sufficiently accurate, and a greater degree of precision be required, let a given quantity be dissolved in dilute muriatic acid. Let a little excess of acid be added, that no portion of the lime may remain undissolved owing to a deficiency of the solvent. Dilute with water, let the insoluble part, if any, subside, and decant the clear liquor. The sediment is now to be washed with further portions of water, and poured upon a filter previously weighed. The filter is then dried, and its increase of weight will indicate how much insoluble matter the quantity of lime submitted to experiment contained. It is easy to judge, by the external qualities of the insoluble portion, what is the chief ingredient in its composition.*

When composts of lime and earthy matters are formed, it is desirable that this should take place before the lime is slacked, as in the conversion of the newly-calcined lime into a hydrate, a considerable heat is generated, and the effect of the lime on the materials with which it is combined is thereby increased.

Lime is one of the most powerful agents at the command of the farmer, in the reclamation of waste land, and without its agency vast tracts must have been left out of cultivation. Even spread over the surface of waste land, without further cultivation, it is attended by the most beneficial effects. Even when it is intended to bring such lands into cultivation, an application of a considerable quantity of lime spread over the surface some time before, will exercise a powerful influence in effecting the destruction of the indigenous herbage, whether heath or bent, and thus prepare the surface for the operations of tillage. A better herbage will thus be produced in the meantime, and should it not be found to be expedient to commence the reclamation of the land until some more distant period, the alteration produced in the herbage will amply remunerate the farmer for the expenditure incurred by the application of the lime. The lime, in this case, being applied to the land in the state of a hydrate, the soluble part is washed into the soil by the rains, and soon returns to its original state of carbonate, after which, being insoluble in water, no portion of it can be carried off the land by rains occurring afterwards. In the event of the process of paring and burning being resorted to afterwards, this carbonate of lime will again be restored to the state of quick lime in which it was formally applied.

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* Henry's Elements of Experimental Chemistry.

Chalk is another compound of lime applied in certain cases as a manure. It differs from limestone merely in its being of a much softer texture, and hence of being broken down with greater facility. It has no action whatever upon inert vegetable fibre, being chiefly valuable in contributing to alter the texture of the soil to which it is applied. It possesses the property of being retentive of water without at the same time becoming adhesive; consequently it can be used with advantage both to clays and sands under certain circumstances. In common with all calcareous matter it neutralizes the injurious effects of certain saline substances frequently to be met with in soils, the salts of iron, for example, and to this circumstance the advantage derived from its application is often to be attributed.

Marl is another widely-diffused and important inorganic manure. It is very variable in quality, from the admixture of certain other substances in its composition; but it is chiefly valuable in proportion to the quantity of calcareous matter which it contains.

The operation of marl is similar to that of lime, but much slower in its effects, and it must therefore be applied in larger quantities. A curious cirumstance to be kept in view in the application of marl, is its injurious effects in many cases, if applied immediately after being taken from the pit, but these effects are completely prevented by allowing it to remain exposed to the air for a certain length of time, and turning it over frequently. It seems difficult to account for this curious phenomena, although the truth of the remark is well established in practice.

With respect to the comparative value of lime and marl as manures, it appears that an application of the former can be made, unless under very peculiar circumstances, at much less expense, and it also produces the desired effect in a much shorter time. The latter is, however, more durable in its effects; and, besides acting on the organic portion of the soil, in consequence of the calcareous matter which it contains, it improves the staple and consistence of it by the large quantity employed. Marl is also found to produce beneficial effects, by altering and improving the mechanical texture of the soil.

Besides lime and marl, calcareous matter is applied in other forms for the purposes of agriculture. One of these bodies is gypsum or sulphate of lime, a substance consisting of lime, sulphuric acid, and water of crystallization. A moderate heat drives off this water, and the gypsum may then be reduced to powder, and applied to the soil in that state. Calcination does not, however, drive off the acid with which the calcareous matter is combined, as in the case of the carbonate of lime. The only object to be gained by the process is, therefore, merely to reduce it to powder, which is essential previous to its application to the soil.

Gypsum has not been applied in a sufficient number of cases in this country to enable us to arrive at any positive conclusions with respect to its efficacy as a manure. The crops to which it has been applied with greatest advantage are the cultivated grasses and leguminous plants. The quantity used is small, being at the rate of four or five bushels to the acre.

Another form in which calcareous matter is applied to the soil may be seen in the case of sea-shells. They abound in various parts, and are largely used as a manure in the country along the sea-coast, and in inland situations to which they can be conveyed by navigable rivers.

They consist of calcareous matter, chiefly carbonate of lime, in combination with a small portion of animal matter.

Lime exists in shells in a state of greater purity than it is usually found in limestone; but shells have not the same rapid and powerful action as lime, except when burned or calcined, an operation which is rarely performed. They are much improved by being crushed or broken in a mill resembling that used for tanners' bark, to give the air readier access to promote their decomposition, and to enable them to be more equally distributed over the surface of the land; but this also is rarely practised. In their natural state, shells are very slow in decomposing and becoming incorporated with the soil, and this property greatly lessens their value as a manure. In order to produce any sensible effect, the quantity applied must be large, varying from three to four hundred bushels to the acre.

Of the saline matters employed as manures, common salt, chloride of sodium, has attracted most attention. It has, in some instances, been extensively used as a manure, though experience is decidedly opposed to its application in any considerable quantity, the margins of the ocean being, with few exceptions, uniformly sterile. Soil, abounding in salt, however, have been found to produce herbage very nutritive and wholesome; and certain saline marshes are highly valued on account of the large quantity of herbage which they spontaneously produce.

There is much diversity of opinion among farmers as to the value of salt as a manure. Nothing decisive has been ascertained regarding either the quantity, or the season in which it should be applied. On soils containing already a considerable portion of saline matter, the quantity to be applied must necessarily be very small; and, in any case, it should rarely exceed five or six bushels to the acre.

Nitrate of potash, or salpetre, has also been applied with good effect as a manure, but further experiments are wanted to confirm its value for that purpose. Being so expensive, it must, of course, be applied in small quantities, perhaps at the rate of a cwt. to the acre. It is chiefly applied to grass lands. The same remarks are applicable to the nitrate of soda, which is also coming into use as a manure.

III.—MIXED MANURES.

This class of manures, it has been said, consists partly of organic and partly of inorganic matters, combined together in various proportions; but the term may also be applied to mixtures of organic matter alone. Thus combinations of farmyard dung with earth, in which there is much vegetable matter, belongs to the class of mixed manures, although the substances incorporated with the dung are chiefly valuable in proportion to the quantity of organic matter they contain.

Mixing farmyard dung, in a decomposing state, with earth in which there is much inert vegetable matter, consisting of roots and leaves of decayed grasses and other plants, will bring it into a state of humidity and solubility, and prepare it for nourishing the plants to which it may be applied. This is, indeed, a mode of increasing the stock of manure upon a farm that should in no case be neglected. The earthy matters, when mixed with the dung, imbibe a portion of its juices, and thus form a compound of excellent quality. It is well known, that when the manure of the farmyard contains a large proportion of animal matters, a considerable waste of the most valuable parts of the manure is often sustained by evaporation, and by a portion of the liquid oozing from the heap and being lost; but by combining a certain portion of other matters with it, this liquid is retained, and the gaseous matters, evolved during the fermentative process, absorbed, and their fertilizing properties applied to the soil.

In the formation of composts, the materials are arranged in alternate layers, for the purpose of effecting a more intimate combination of their parts, and rendering the whole of a uniform quality; but this arrangement need not be strictly observed, since the different substances may be mixed together whenever they can be conveniently collected. The mixture may be formed in the yard in which the manure is kept, and it will have the advantage of imbibing the urine from the cattle sheds, which will much improve its quality. But it has been seen, in treating of organic manures, that conveying the manure at intervals to the field as it is made, or at such periods as the other labours of the farm cannot be carried on, economizes time at the season of more active labour; and this is particularly applicable with respect to the class of manures now under consideration, as being more bulky than farmyard dung; besides, it not unfrequently happens, that a portion of the earthy matters for the compost may be found in, or around, the fields to be manured. It is, therefore, better to form the compost heaps on the head-lands of the fields.

A convenient situation being chosen, a layer is formed of peat-earth, weeds, road-scrapings, scourings of ditches, or similar matters, six or eight inches in depth, and on this a layer of farmyard manure, and so on, until the whole is completed. The materials are to be regularly spread on the heap as they are conveyed to it; and, after being finished, it may be covered with earth in the manner already explained.

From the account of the nature and properties of peat-earth, given in another part of these pages, it will be seen, that it is peculiarly adapted for entering largely into the formation of composts; and there are few situations in this country in which an abundant supply of it is not available. From its tendency to render soils to which it is applied less adhesive in their texture, it forms a valuable addition to the stock of manures on clay farms; but on sands and gravels it has not been generally found to answer. It should be exposed to the atmosphere some time previous to its being employed in the formation of compost. The quantity of dung should be nearly equal to that of the peat; and when a certain degree of fermentation has taken place in the heap, the mass should be turned over, and formed into another heap; and an additional turning may be necessary before it is used.

In the selection of materials for composts, a rule of universal application is, that they should differ as much as possible, in their constitution and texture, from the soil to which they are to be applied; and that they also should have a tendency to correct its defects. Earth taken from arable fields that have been long in cultivation seems the least suitable to enter into the composition of these heaps; and, even when in combination with the dung, possesses no fertilizing properties that would not be produced by the application of the same earth and dung separately, for there is generally comparatively little inert matter in this description of earth to be rendered soluble.

It has been recommended, both in the management of composts and of farmyard manure, to preserve them from the influence of the atmosphere, until it is desirable that fermentation should take place. As manure heaps are formed by degrees, it it well to retard the fermentation of that which is first made, or retain it in a state of fermentation so slow as to produce no sensible effect, till after being turned over with the later-made dung, it forms one powerfully fermenting mass. It should be deposited in the soil when the process is so far advanced that it will be completed after its application; when, at the same time, little loss of substance has been suffered, and when what volatile matter is afterwards extricated will be diffused through the soil. But although fermentation is retarded by the compression given to the materials, and no injury can be sustained by its action, yet it is highly improper to allow the heap to remain too long in this state before being applied to the land. Fermentation is suspended, but, after a time, decomposition will commence; and the mass will be brought to a state in which it will be impossible to make it afterwards undergo even the slightest degree of fermentation. In properly-fermented manures mucilaginous and other fertilizing matters are abundant; but they are absent altogether, or present only in small quantities, in such as have been slowly and gradually decomposed.

When a proper proportion of animal and green succulent vegetable matter is present, the required degree of fermentation is generally easily produced by turning over the heap. The propriety of placing the materials loosely after turning has already been pointed out. If a single turning is insufficient, a second must be given, observing in every case to incorporate the materials thoroughly together by a more intimate comminution of their parts.

The necessity of not only guarding against any waste of the farmyard dung, but also of every thing in the shape of refuse animal or vegetable substance, cannot be too much pressed upon the attention of the farmer. In addition to the compost heaps formed in the fields, another may be formed in some spot convenient to the farm buildings, and upon it every particle of offal collected about the premises should be regularly thrown. There also may be added the scrapings of roads and walks about the house, grass, turf, rubbish from drains or ditches, every thing, in short, which, by decomposition, can be converted into manure; and all of which may be collected with very little trouble. Care is to be taken that the vegetative powers of roots and seeds in the heap be completely destroyed before the compost is applied to the land. Composts thus formed will be found a valuable species of manure. The whole substance becomes one mass of nutritive matter, which may be either mixed with the soil, or applied as a top-dressing, either to arable or grass lands, and, with proper attention, it may be got ready at any season of the year.

Weeds by the sides of roads and fences should never be permitted to mature their seeds, but should be invariably cut down while in a green and succulent state, and added to the heap; and if those turned up by the process of horse-hoeing were also raked off and carried to it, instead of being allowed to wither on the land, or spring up again after the next shower of rain, it is inconceivable what a large quantity of manure would be thus accumulated. It would also contribute, in a material degree, to that neatness which forms a distinguished feature in careful cultivation.

Were the practice of soiling more generally practised, it would also very materially add to the stock of manure. A great increase in the secretion of urine is known to take place when cattle are fed on green food in the houses or stalls, and the quantity is further increased by the heat of the season. The materials employed as litter are, therefore, soon saturated with urine, and, being mixed with the dung, are speedily converted into manure. In the usual practice of farm management, the quantity of manure produced in the summer months is inconsiderable, compared with that produced in the winter; but were the animals of the farm confined a greater part of the time in their houses or yards during the summer, and supplied with abundance of green food, the manure accumulated in that season would form a large part of that produced in the year.

The collection, management, and application of manure are of the utmost importance to the farmer, and we have accordingly devoted a considerable space to the subject. In the present state of agriculture, arable land cannot be made to repay the expenses of cultivation without the most skilful and economical, though unsparing use of manures. But a very small portion of the land under tillage is capable of bearing crops, unless the exhaustion occasioned by cropping be restored by nutritive and stimulating substances, once, at least, in every four or five years, or that it be allowed to remain for more than the usual length of time in the production of grass. To obtain the requisite quantity of organic manures, has hitherto baffled the exertions of many industrious farmers, unless in the neighbourhood of large towns. There the object is often obtained through the medium of purchased dung, the expense of which has generally been amply repaid by the production of proportionally increased crops; but the farmer who is dependent on the produce of his own farm for supporting the fertility of the soil, should endeavour to cultivate those crops which are best calculated to make a large return of food for the maintenance of live stock, by which an increased stock of manure will be produced.

The whole subject of manures is, in fact, one of engrossing interest to the farmer. The operation of this class of substances is interesting to the physiologist, who can make no proficiency in his study without attempting the investigation of the means by which plants derive their food from the soil. The application of manures in a concentrated form, such as bones, night-soil, and a number of other substances, is calculated to be of vast importance in the improvement of agriculture. They are so portable that the expense of transit from one place to another is inconsiderable, and being placed in immediate contact with the roots of the growing plants, they are capable of promoting their growth in a manner superior to the more bulky manures. The peculiar action of the component ingredients of these substances on vegetation is at present engaging much of the attention of scientific men, and the best results may be expected from their investigations.

III.—IMPLEMENTS OF THE FARM.

THE operations of husbandry are numerous and important, and on the manner in which they are executed depends the success or failure of the farmer. They are performed by means of the various implements and machines of the farm—these being worked either by some of the domestic animals, as the horse or the ox, or by manual labour. In order to correctly understand the manner of performing the labours of the farm, it is essential that a certain knowledge should be acquired of the mechanical agents employed for the purpose.

Great Britain has long been famous for the manufacture of machinery and instruments, having for their object the execution of a given amount of labour, by means of the application of a smaller comparative force. The superiority of British agriculture over that of any other country is, indeed, in a great measure, to be ascribed to the great degree of perfection attained in the construction of the implements employed. The number of implements used in agriculture is very great, and the ingenuity of farmers and mechanists is daily adding to the original stock; but it is conceived, that a comparatively small portion of them only is absolutely essential, so that a considerable degree of practical knowledge is necessary to distinguish between those which are really essential, and those which are used merely from prejudice or caprice.

The implements or machines of the farm may be divided into classes, according to the purposes for which they are used:

1. Implements of preparatory tillage.
2. Machines for sowing.
3. Implements for hoeing.
4. Machines for thrashing and preparing grain.
5. Machines for preparing food for live-stock.
6. Implements of conveyance.
7. Implements of manual labour.

I.—IMPLEMENTS OF PREPARATORY TILLAGE.

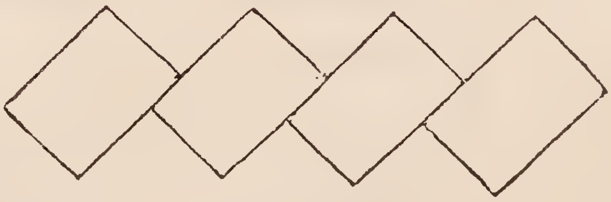
1.—*The Plough.*

The plough, being the fundamental implement of agriculture, is common to all civilized countries, and its primitive form is almost every where the same. That found in some districts in Ireland, even at the present day, is as rude an instrument as can well be conceived. Through the agency of the several agricultural societies the improved Scotch plough was introduced into this country, and it was subsequently extended by the emulation excited by means of the ploughing-matches held in different parts of the country. This is the plough which will be referred to in the following pages. It is perhaps more generally known in Ireland by the name of the Wilkie-plough, from the circumstance of most of the ploughs imported being manufactured by Wilkie, an eminent mechanist near Glasgow.

The object gained by using the plough, is the turning over of the soil to a given depth, and thus exposing a fresh surface. This is effected by the instrument passing along the ground, and cutting successive slices of earth in its progress, which are to be raised and laid over in such a manner, that each sod or slice shall be laid resting on the preceding one. When the work has been properly executed, these slices will be placed at a certain degree of inclination to the plane of the horizon, and the skill of the ploughman is known by the precision and regularity with which this object is accomplished.

In ploughing, the furrow slice would be completely reversed, were it not for the support which the several slices or sods afford to each other; but this intervening obstacle being opposed to the descent of each successive slice, it is laid over in the manner just stated. The angle of inclination at which these different slices will rest upon each other, as shown in the figure, depends upon the proportion which the width of the slices bears to their depth. Now, it will easily admit of demonstration, that the angle by which the greatest surface of the fresh turned-up earth will be exposed to the influence of the atmosphere is 45°; and in order, therefore, that the slices may be

Fig. 1.



laid at this angle, the proportion which the width bears to the depth is to be determined. This is done by simple calculation, for these dimensions respectively form the hypothenuse and one of the legs of an isosceles right-angled triangle. Thus, if the depth be assumed at 5 inches, the breadth will be 7·07106 inches; but in practice the proportion usually known amongst ploughmen is as two is to three.

Seeing then the nature of the operation which is to be performed by means of the plough, and the manner in which it ought to be executed, we shall be better enabled to judge of the adaptation of the several parts of the instrument for the purpose required.

The adaptation of the improved Scotch plough for the execution of the work required, shows that the most minute acquaintance with practical mechanics was necessary in its construction. This knowledge is, however, rarely possessed by the farmer, nor even by the greater number of those who now manufacture the instrument. The usual practice is to select a plough of an improved construction as a model, and this the manufacturer endeavours to imitate; but, as might be expected, failures sometimes occur, for it is only when the imitation has been perfect, that the implement will properly perform its work.

In the operation of ploughing, the slice to be turned over is first cut from the unploughed land, by means of the coulter, preparatory to its being laid over by the other parts. The coulter is formed with a sharp cutting edge in front, to afford little resistance to the working of the plough; and to keep this part from wearing, and also to preserve a good edge, it is well that it be formed of steel. It is firmly fastened into the beam, from which it extends almost to the point of the share, with its forepart so inclined as to form about an angle of 45° with the plane of the sole of the plough. The position of the coulter cannot, in any case, deviate considerably from this angle; for, if placed more oblique, it causes the action of the plough to be impeded by stubble, and the roots of grass or similar matters, being collected and retained between the coulter and the beam; and if less oblique, it increases the resistance in passing through the soil, by carrying stones or other obstacles forward in its course. Being fixed in a mortise in the beam, it may be raised or let down as circumstances may require.

The coulter having separated the furrow-slice from the unploughed land, the share passes under it, and elevates it, in order that it may be laid over. This part of the instrument is made to be taken off with facility, in order that it may be sharpened and otherwise repaired when necessary. It is formed with a wing or projecting edge to the right-hand side, which is laid with steel on account of the friction to which it is subject. The purpose of the wing, or *feather*, as it is frequently termed, is to cut the under part of the furrow-slice previous to its being raised upon the mould-board, by which means the operation of raising and reversing the sod is better performed, and with less waste of labour. The extreme breadth of the wing may be seven inches, and the entire length of the share, from the point to its junction with the mould-board, thirteen inches. It is better that the breadth of the wing of the share be somewhat less than that of the furrow-slice in ploughing, for when the whole breadth of the sod is cut through below, it is liable to be pushed aside by the plough before it begins to rise upon the mould-board, and in this case it cannot be laid in its proper position; but when a small part of it is left uncut it is kept firm in its place so as to allow the forepart of the share and mould-board to raise it up in the manner desired, without crumbling it or pushing it aside.

After the furrow-slice has been thus separated from the surrounding earth by means of the coulter and share, it is to be further elevated by the mould-board, and finally laid over in its proper position. The share is formed of malleable iron, it being often to repair, and the mould-board of cast iron. The share and mould-board, combined, form a curved surface, which, beginning at the point of the share, gradually rises from the horizontal plane, becomes vertical as it approaches the centre of the mould-board, and then continues to incline in a uniform manner to the right-hand-side, until, at its extreme point, it inclines over to that side at the angle at which the furrow-slice is to be laid. The whole right-hand side of the plough, therefore, consisting of the share and mould-board, forms the curved surface of a wedge, which, being insinuated beneath the furrow-slice, and pushed forward, gradually raises it to a perpendicular position, and then, by acting upon the upper part of it, presses it over into the position in which it is to remain.*

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* Elements of Practical Agriculture, p. 82.

The perpendicular height of the mould-board may be from fourteen to sixteen inches, being that which is sufficient to prevent the loose earth from rising over the top in deep ploughing; for it is to be observed, that although we have, for the purpose of illustration, been speaking of the movement of a sod only, that is, of a body whose parts are in a certain degree bound together, the plough has also to act upon loose earth. The extreme width of the plough below, or, in other words, the distance of the lowest point of the mould-board from the land side of the plough, should not exceed the width of the sod which it is intended to remove.

That part of the plough next the solid land is defended by plates of cast iron, the lower one of which is turned round, and forms what is technically termed the sole. This part, being subject to great friction, is made thick, and is of such a length from the junction of the share to the other end of it, which is called the heel, as to give steadiness to the instrument. It is usually from thirty-two to thirty-four inches.

The beam of the plough is the part to which the moving power is attached. It also serves to connect all the other parts of the instrument together. The head, or bar to which the sole-plate is attached, is joined to the beam by the sheath, along which the front part of the mould-board rests. The perpendicular height of the sheath may be from thirteen to fifteen inches. It is inclined backwards to the plane of the sole of the plough, and its forepart forms nearly the segment of a circle, to correspond with the forepart of the mould-board.

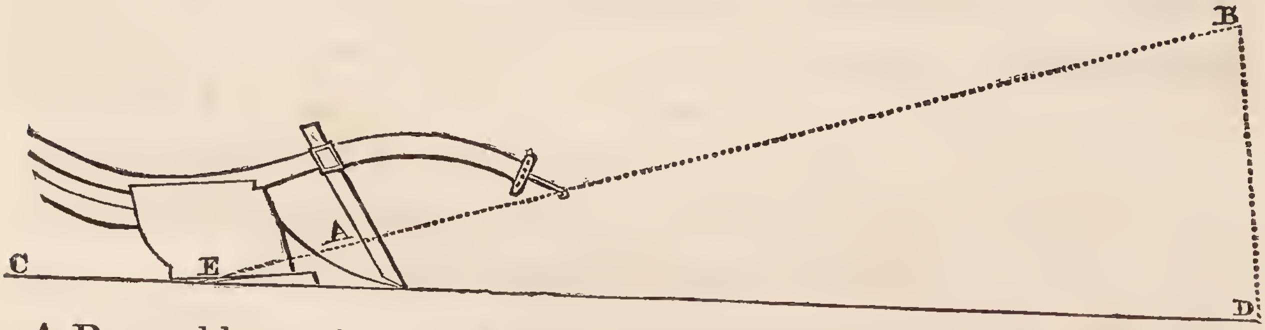
The beam being the part of the instrument most endangered by sudden shocks, it must be made of a good degree of strength. Upon the end of it is placed a bridle, or muzzle, as it is indiscriminately termed, to which the point of draught is fixed, and by means of which the line of draught can be elevated or depressed, and moved to the right hand or to the left, as may be required. The beam is curved in its form, in order that, being more elevated above the surface of the ground, it may be less impeded by stubble and other matters upon the surface.

The beam in connexion with the plough may be regarded as a bended lever. When any stone or other obstacle resists the coulter or share in its progress, the heel of the plough tends to rise, and that until the point of the beam is sufficiently depressed to restore the equilibrium. The increasing of the length of the beam then increases the power of the lever, and tends to render the motion of the instrument more steady; but by increasing its length, the other parts of the plough must also be increased in dimensions, and so add to its weight. It is found therefore, that, for practical purposes, the beam should not exceed seven feet in length, measured from the bridle to the hinder part of the left handle.

One of the chief difficulties attending the construction of the plough is to form it so that it shall preserve a steady and regular motion in the ground during the operation of ploughing. This motion is found to be affected not only by the form of the different parts of the instrument, but also by the manner in which the moving power is attached, or, in other words, by the height and position of the beam; for to this part the moving power is applied.

Were it ascertained by experiment on the plough, when at work, at a given depth of furrow, and in soil of a given texture, that a cord attached to any point A, *Fig.* 2, and drawn in the oblique direction

Fig. 2.



A B, would so pull forward the plough, that it should press uniformly upon the earth at all points, from C to D, so that the share should neither tend to point upwards nor downwards, but should move horizontally forward,—then it is to some part of this line that the moving power should be applied; and further, it is known, from the principles of mechanics, that it matters not, in so far as regards the force exerted, to what precise part of this line the power is applied. It has also been ascertained in practice that such a line, drawn from the usual point of attachment of the draught on the collars of the working cattle, will intersect the sole of the plough at E.*

The handles of the plough yet remain to be noticed. Being much less exposed to injury than the other parts, they are made proportionally light, and are terminated at their extremities with pieces of wood inserted into sockets, for the hands of the workman. The left handle, when viewed from the land side, appears to be a direct continuation of the beam, these parts being mortised together; but both handles usually terminate at the head of the plough, and to this part they are attached. An important improvement in the construction of the instrument consisted in placing the left handle so as to stand seven or eight inches to the left of the plane of that side of the plough, as shown in *Fig.* 3. The handles being thereby removed from the space in which the ploughman should stand, he is enabled to keep the instrument in a more upright position.

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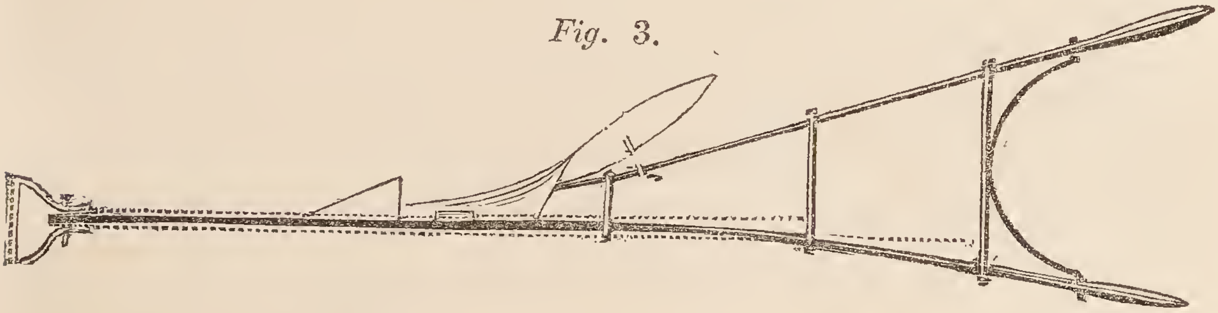
* Elements of Practical Agriculture, p. 85.

Fig. 3.



The manner in which the working cattle are attached to the plough does not require illustration. A chain, varying from a foot to sixteen inches in length, connects the bridle of the plough and the hook attached to the centre of the foot-tree, and to this the swing-trees are attached, from which chains extend to hooks on the collars of the animals. These chains, or traces, as they are frequently termed, are prevented from falling down by a broad belt of leather passing over the back of each horse, on which are hooks fastened on each side to the traces.

In the operation of ploughing a considerable knowledge of the instrument is essential, and a facility in adjusting it to suit the different sorts of soils, and the different methods of ploughing, is an indispensable qualification in the person who is to use it. Much of the efficacy and value of the plough, it is true, depends on the manner in which it has been constructed, as the ploughman can only control its operation to a limited extent; but much also depends on the accuracy of adjustment of the several parts over which he has absolute control.

The position of the coulter, it has been seen, admits of modification. The left side ought to be placed in the same plane with the left side of the plough. If the coulter be inclined either to the right hand or to the left, the resistance to the forepart of the plough is increased, as well as the chance of its being impeded by obstacles in its progress; for if a stone, or the like, were to strike the coulter, the same, or another stone, might also strike the forepart of the sheath; and further, this stone might, by striking at the same time the coulter and the sheath, be carried forward in the interval between them, through the firm land. Again, if the coulter be thus inclined, a bias is given to the plough in that direction in which the coulter points. Thus, if the coulter points to the left, the plough will have a tendency to turn more into the firm ground on that side. Nor is it enough that this tendency may be counteracted by other means, as by moving the line of traction more to the left by means of the bridle attached to the beam. This opposing of one tendency by another is a defect, when it can be avoided, the consequence of such opposing powers being to expose the instrument to greater strains and pressure, and to increase the labour in moving it forward.

In adjusting the share, the proper position is determined by the application of a straight-edge, first to the left-side plate and extended along the share, and next along the sole of the plough; and with this the side and bottom of the share should perfectly coincide.

The height at which the traces are fastened to the shoulders of the animals, and the different depths at which it is necessary that land should be ploughed, make a considerable deviation in the position of the line of draught, and consequently in the mode of action of the instrument. But, that it may suit itself to these variations, as well as that any defects in the form of its parts may be counteracted, the bridle at the end of the beam is made to elevate or depress the line of draught, as may be required. Should the plough, for example, tend to go deeper into the earth, the line of draught may be lowered by means of the bridle, the effect of which will counteract the tendency which the plough had to go deeper than required, by throwing a greater part of the weight of the machine behind the direction of the moving power. The same effect is produced by shortening the traces. In like manner, the point of draught may be shifted to the right or to the left.

The plough is, however of the most perfect form when its various parts are so adjusted that they shall not oppose each other's motion; but it is very difficult to form a plough that is perfect in the form and combination of its parts. Even in those of the best construction, there is frequently found to be a tendency to rise out of the ground, or to turn to one side, generally the right hand or open side. The tendency to rise out of the ground can be corrected by giving an inclination downwards to the point of the share, and the tendency to turn to the open side can be obviated by turning the point of the share slightly to the left-hand side. But by these means the labour of draught is increased, and care must therefore be taken that this *tempering of the irons*, as it is called, be not in any case carried further than is necessary to correct the defects of the instrument. All that is necessary beyond this is effected by changing the position of the line of draught, by means of the bridle on the end of the beam.*

The common plough has now been described. It is often necessary, however, to give a deeper ploughing to land than the ordinary depth of furrow, and this may be effected in various ways. One plough may follow another, the mould-board of the former being taken off, and in this way a considerable depth of furrow may be obtained; or what is better, the subsoil plough may be used for that purpose. It is the invention of Mr. Smith, of Deanston, a gentleman to whom the agriculturists of the United Kingdom are much indebted.† In the operation of this plough the common plough is used to remove

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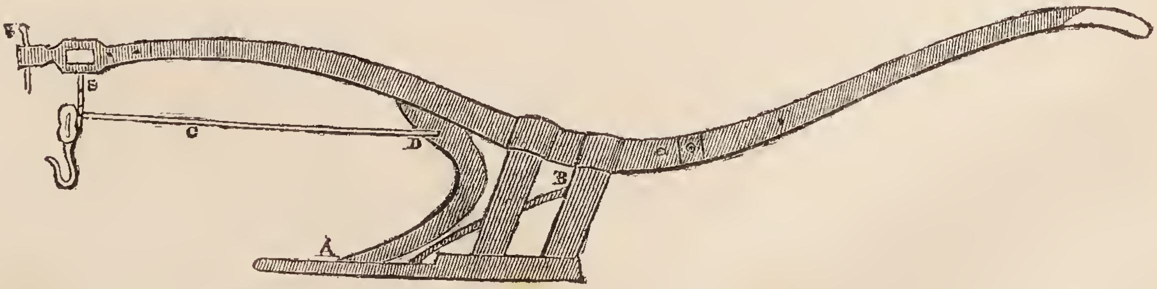
* For further information on this subject, see the Quarterly Journal of Agriculture, vol. i. pp. 409-429, and Low's Elements of Practical Agriculture, from which the greater part of this article has been extracted.

† The subsoil plough which is figured below was designed for the purpose of opening up retentive subsoils. In the design two essential points are kept in view. 1. The construction of an implement that would effectually open up the subsoil without bringing any of it to the surface; and, 2. To have it of the easiest possible draught for the horses, while it was of sufficient strength and weight to penetrate the hardest ground, and resist the shocks on the largest stones.

Fig. 4.



The extreme length of the plough is about 15 feet. From the socket at the point of the beam to the first stile or upright, 6 feet; thence to the back of the second stile 19 inches; thence to the outer end of holding handles, 7 feet; from the furrow-slice of the surface. The subsoil plough then follows in the track thus made, to break up the subsoil: and in this manner the ploughing of the surface, and the breaking up of the subsoil, proceed simultaneously until the whole field is gone over.

Ploughing is justly considered the most important of agricultural operations, as on the manner in which it is performed depends the facility of executing all the succeeding ones on the same piece of land. The plough has been seen to act as a wedge, separating a portion of the soil from the unploughed land, and turning it over at the same time. If this wedge were properly constructed, and the soil presented everywhere the same uniform resistance, the plough would require no holding, but would maintain its position when drawn along by the cattle. The least inequality of surface or tenacity, or the additional resistance of a root or stem, however, destroys the equilibrium of the forces acting against the wedge, and the presence of the ploughman then becomes necessary to maintain the instrument in its proper position, and to enable it to overcome the obstacles which may be opposed to its progress. The steadiness of its motion is found to be affected by the distance or proximity of the working cattle; but yet it is advantageous that they should be harnessed as close to the

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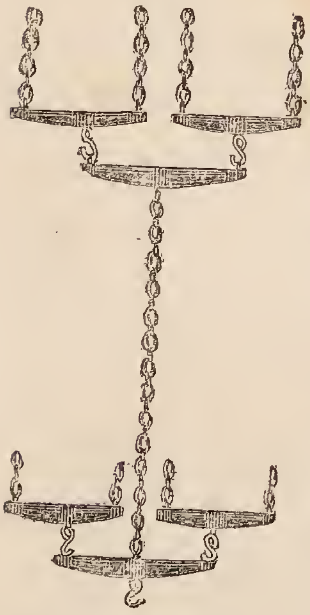
the sole to the bottom of beam at stiles, 19 inches; length of head or sole bar, 30 inches; from heel of sole to point of sock, 46 inches; broadest part of sock 8 inches. The coulter is curved, and in order to prevent its point being driven from its place by stones, it is inserted to the depth of an inch in a socket A. The lateral dimensions of the sole piece are two inches square. This is covered on the bottom and land side with a cast iron sole piece to prevent wear. The share goes on the head in the usual way, and from its feather rises the spur piece, B, for the purpose of breaking the subsoil furrow. When the subsoil consists of very firm clay, or other hard and compact earth, the feather and spur piece may be dispensed with, and a plain wedge or spear-pointed share may be used. The draft-bar C, of $1\frac{1}{4}$ inch sound iron, is attached to the beam at the strong eye, D, and passing through an eye in the upright needle, E, is adjustable to any height or lateral direction, being moveable in the socket, F, at the point of the beam, and can be made fast at any point by a pinching screw worked by the lever, G, By the proper setting of the draught-rod, the direction of the power of the horses is so regulated as to render the guiding of the plough easy at any depth or width of furrow. The beam is about 5 inches deep in the middle, and $1\frac{1}{4}$ inch in thickness; towards the draught end it tapers to three inches deep, and 1 inch thick. The weight of the implement is 400lbs. This appears an enormous weight, but after repeated trials with lighter ploughs, those of the dimensions and weight plough as convenient, by which the amount of resistance in drawing it forward is lessened. The left-hand or near-side horse walks on the unploughed land, the right-hand or off-side horse walks in the furrow last made; and when there is any difference in regard to size and strength, the more powerful horse should be placed in the furrow.

The depth to which the plough should penetrate into the soil is regulated by the nature of the soil itself, and by the object in view in ploughing. The seed-furrow for grain or the grasses should be light, seldom exceeding five or six inches, but in preparing land for fallow crops, it is generally necessary that it should be much deeper. Pulverization has been seen to be a mean of maintaining the fertility of the soil, and preparing it for the seeds of plants, and deep ploughing is essential for that purpose.

The furrow-slices, in ploughing, are generally distributed into beds, varying in breadth according to circumstances, and these beds are termed ridges. The ridges are separated from each other by

now described have been found to be at once the most efficient, the most easy of draught, and the easiest for the ploughman to manage.

Fig. 5.



Four ordinary farm horses are generally sufficient to draw this plough in breaking up subsoil of ordinary firmness; but on very tough clays or very hard till, it may be necessary to use six horses. When four are used they are yoked two and two by draft bars and chains, as shown in *Fig. 5.* The main chain for the leading horses to pull by, is hung by links from the collars of the near horses, to keep it from their legs, and the trace bars of the leaders are kept close up to their hams by cross straps over their quarters.

When horses which have been accustomed to work in pairs, are first put to work in this plough, they are apt to be a little restive, and do not at first pull well together, and this is especially the case when the subsoil is strong. The ploughman also finds some difficulty in balancing the plough at first, and if he is not a man of quiet and firm temper, the whole affair puts on the appearance of an arduous and hopeless undertaking. A few hours or days at most, however, of temperate perseverance, will overcome all difficulties, and horses and men will work together with steadiness and effect. The work is, indeed, in most cases, severe, and the horses are frequently warm and fatigued; but to insure good farming the work must be done, and will amply repay all the trouble and expense. —*See Remarks on thorough Draining and deep Ploughing by J. Smith, Esq., Deanston.*—Stirling, Drummond & Sons, 1838.

open furrows, which also serve as guides in sowing and reaping, and several other processes in agriculture. In soils of a strong retentive nature, or which are incumbent upon close retentive subsoils, these open furrows serve, likewise, for drains to carry off the surface-water, and being cleared out after the seed is sown, they are termed *water-furrows.* In the moist climate of this country this forming of the land into ridges is necessary, so as to admit of the water which falls upon the surface finding a ready egress; and even in lands so dry that little injury will result from stagnating water, such ridges are generally formed on account of their convenience in the different operations of tillage. The breadth of the ridges is to be regulated by the nature of the land, and, accordingly, they may vary from twelve or fifteen to twenty feet, and sometimes more.

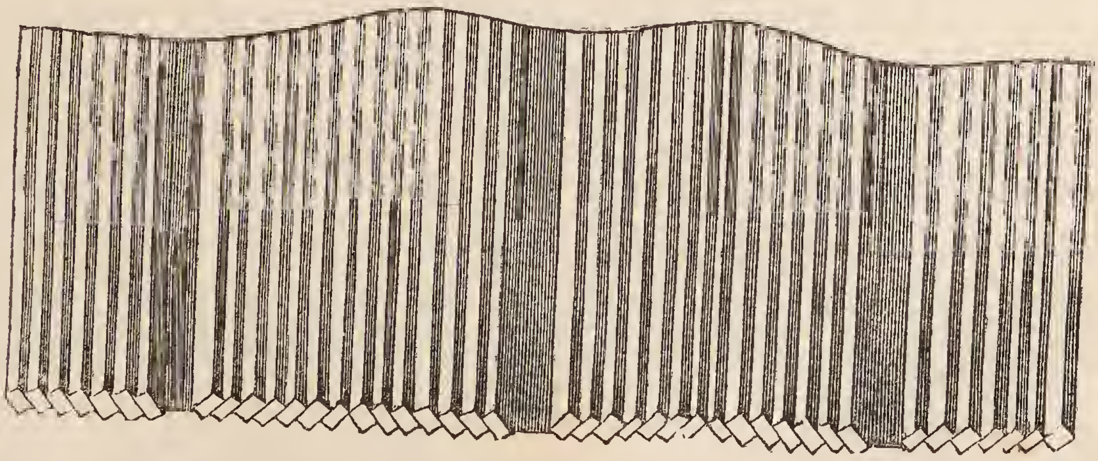
The first process in commencing to plough a field in which no traces of ridges exist, is to mark it off into parallel and equal divisions, each corresponding in size with that of the intended ridges. This is performed by means of poles, three of which are required; and it is convenient that they should have feet and inches marked on them, in order that the ploughman may be enabled to mark off his ridges with facility and precision. The poles are placed in a right line, and along this line the plough is to pass, the poles being a guide for the ploughman to direct his horses in the proper course. Having proceeded so far as the first pole, he stops the horses and removes it, at the same time measuring the required distance for the breadth of a ridge from its original situation along the unploughed land, and there setting it up. On arriving at the second, he performs the same process, observing, in measuring the distance, that it be done in a direction perpendicular to the line of the furrows. In setting up the third, or remaining pole, it will not be necessary to measure the distance, as in the case of the others; for the two already placed will serve at once as a guide for placing the third in the same right line. Having reached the end of the field, the plough is to return by the same furrow, and clear out the other side; and in this manner the operation is carried on until the ridges of the field are marked off. The poles are successively placed in their proper position as the plough advances, in order to save the ploughman the trouble of walking from the end of the field each time to adjust them.

A part of the ground at the ends of the field necessarily remains unploughed, being required for the horses to turn on; and, as it is conducive to neatness that the several furrow-slices should be carried out precisely to the same length, it will serve as a guide for the ploughman to have the required space marked off by the plough, previous to marking off the other ridges of the field. These are called the headlands of the field. They may be sixteen feet in breadth, being that which is found sufficient for horses to turn on. After the rest of the field is ploughed, the headlands themselves are to be ploughed and formed into ridges.

The field is now prepared for being ploughed into ridges, and the ploughman, beginning at the left-hand side of the open furrow, ploughs his first furrow-slice towards it. He then, returning by the opposite side, performs a similar operation, causing the first two furrow-slices to rest upon each other. In this manner he continues, always turning to the right-hand side, and laying his furrow-slices towards the centre of the ridge, until he has ploughed the half of the spaces on each side of the open furrow at which he commenced, after which he removes to the next, and so on until the field is ploughed. But instead of turning the horses to the right about, as has been mentioned, he may, after turning over the first furrow-slice, turn to the left about, and return by the next open furrow, and so on, always laying his furrow-slices towards each of these open furrows alternately.

The position of the several furrow-slices is represented in the accompanying figure. The ridges will be seen to have attained a certain degree of curvature by the process, and this will be increased by successive ploughings in the same manner. It is important that this

Fig. 6.



degree of curvature should be uniform throughout, so that the ridge shall not have what is technically called a shoulder, or hollow part on each side of the centre. It is to prevent this defect that the open track is made along the centre before the first two slices are laid together; by which means the ploughman is enabled to lay them upon each other in such a manner that they shall not overlap, or form a protuberance at the crown of the ridge.

The proportion which the breadth and depth of the furrow-slice should bear to each other has been already stated; but in practice an approximation only can be made to the precise proportion. The ploughman is, however, enabled to discern at a glance whether the deviation from it has been considerable, or otherwise.

Land thus formed into ridges is afterwards cultivated, without marking off the ridges again until the furrows have been obliterated by a fallow or fallow-crop. The mode of ploughing practised afterwards may be one or other of the following. If the soil be dry, and the former ridges not considerably elevated, they are split out in such a way that the space which the crown of the old ridge occupied is now allotted to the open furrow between the new ones. This is technically called *crown-and-furrow* ploughing. When the soil is naturally wet, or if the ridges have been considerably raised by former ploughings, the form of the old ridges and the situation of the furrows are preserved by what is termed *casting;* that is, the furrow-slices of each ridge are all laid in one direction, while those of the adjoining ridge are laid the contrary way, two ridges being always ploughed together. Lastly, on soils very tenacious in quality, it is frequently necessary to elevate the crown of the ridges considerably; and this is effected by what is called *gathering*, which consists in making the furrow-slices on each side of the ridge incline to the centre, the elevation of which is thereby increased.

In the process of preparing the land for green crops, it is frequently ploughed, but, in this case, it is seldom necessary to bestow the same attention to the execution of the work, as in giving the seed-furrow to the land. The intention in the former case is chiefly to stir and pulverize the soil, and, although the same neatness is not required for these purposes, yet it is essential that the ploughing should be of an uniform depth, and that none of the ground should remain unploughed. The ploughings are, in this case, frequently given in a direction crossing that of the former ridges; but the mode of marking off the ridges, and performing the work, is not different from that which has been described.

In ascertaining the direction of the ridges of the field, attention must be paid to the sloping of the ground, and the position of the ditches and fences, so that the surface water may be conveyed off the land. It is an advantage to have the ridges north and south, which insures the same degree of exposure to the rays of the sun on both sides; and when other circumstances are alike, this direction is to be preferred.

When the degree of inclination in the land to be ploughed is considerable, it is frequently necessary to form the ridges diagonally along the slope or inclination, for the purpose of rendering the draught lighter on the horses in ascending the hill, and of lessening the danger of much of the fine mould of the surface being carried away by currents of water in their descent. In this case the ridges are to be inclined to the right-hand side in their ascent, the degree of inclination being regulated by the sloping of the ground.

The quantity of land which can be ploughed in a day depends on a variety of circumstances. Even under the most favourable circumstances, it is found to depend, in a great degree, on the length of the ridge; for, when this is inconsiderable, a large proportion of the time is occupied in turning at the head-lands of the field.* The common calculation, where good ploughing is practised, is, that a pair of horses will plough an acre, when in grass, in nine hours.

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* The following table shews the time required to plough an acre of land, the length of the ridge, breadth of the furrow-slice, and rate of walking of the horses, being given :—

Length of Ridge.	Breadth of Furrow.	Furrows in an Acre.	Time lost in turning in ploughing an Acre.	Time occupied in ploughing an Acre, the rate of walking being—			
				1 Mile per Hour.	1½ Mile per Hour.	2 Miles per Hour.	2½ Miles per Hour.
Yards.	*Inches.*		*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*
66	8	330	2 45	15 07	11 00	8 56	7 42
132	—	165	1 22	13 44	9 37	7 33	6 19
264	—	82	0 41	13 03	8 56	6 52	5 38
396	—	55	0 27	12 49	8 42	6 38	5 24
594	—	36	0 18	12 40	8 33	6 29	5 15
792	—	27	0 13	12 35	8 28	6 34	5 10

2. *The Harrow.*

The harrow is an implement of equal antiquity with the plough, and is of universal use in tillage. It consists of a frame of wood or iron, in which a certain number of teeth is fixed, which are pressed into the ground by their own weight and by that of the frame. It is intended to pulverize the ground which has been turned over by the plough, to disengage the root-weeds from it, and to cover the seeds of the cultivated plants. The construction of the harrow has been less improved or attended to in this country than that of the plough, the form usually employed being defective, although the operation of the harrow is not less important than that of the plough.

The purposes for which the harrow is intended, and its mode of operation being understood, the next inquiry is, to what extent the implement is calculated to effect the object in view, and what particular form is to be given to it for that purpose. In determining the form and construction of the harrow, it is necessary to keep in view the several operations which it is intended to perform. Were it the purpose, in harrowing, solely to drag up the roots of plants and other substances from the ground, a different form should be given to the teeth to enable them to effect that purpose to advantage. In this case a degree of inclination forward would be necessary, as in the case of another description of instruments to be afterwards noticed. But although this construction might be best calculated for tearing up roots and other substances beneath the surface, it would not be so well fitted for covering seeds, and for breaking and pulverizing the ground. In covering the seeds of grain and of the grasses and leguminous herbage and forage plants, the object is to give as great an agitation as possible to the upper particles of the soil, to afford a proper covering; and as this is to be regarded as the most important purpose for which the harrow is used, the form of the teeth must be especially adapted for that purpose. That form which has been found most efficacious is when the horizontal section of the tooth is a square, being moved forward in the direction of its diagonal.

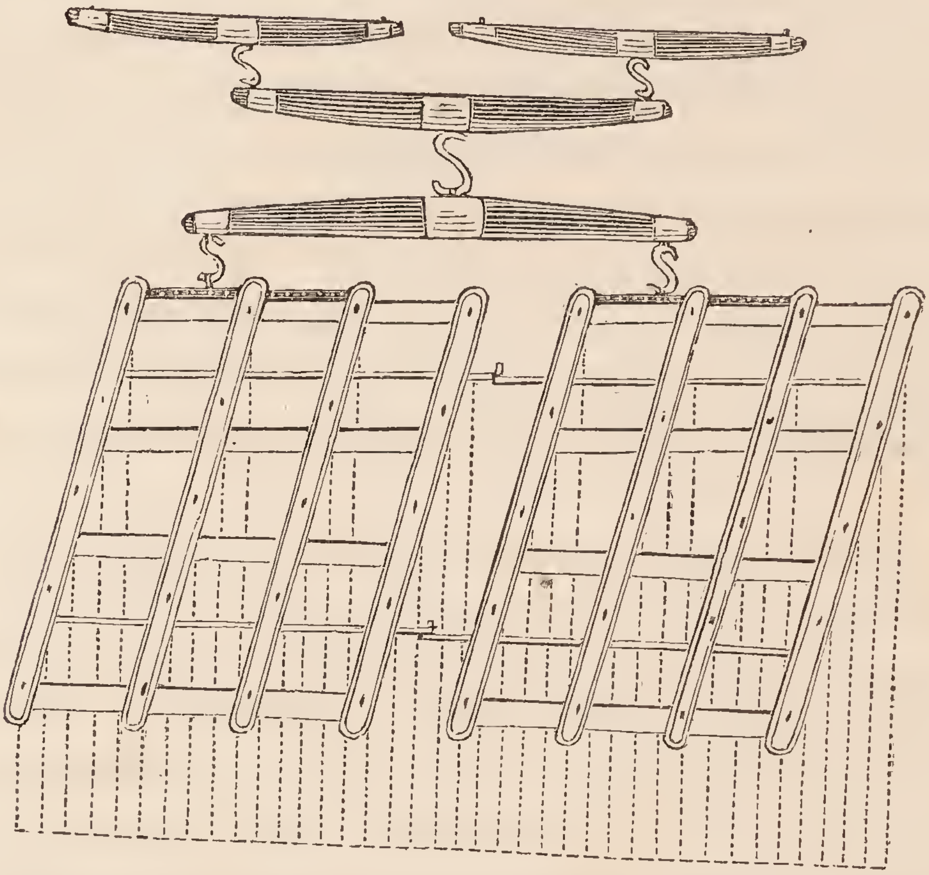
The proper distribution of the teeth is the next point demanding attention. They are not to be placed too closely together, for then the motion of the instrument would be impeded by the resistance of obstacles opposed to them. Another disadvantage attends too close an arrangement of the teeth: in proportion as the number of teeth is increased, their power to penetrate into the ground will be diminished, unless the weight of the whole instrument shall be increased in a corresponding degree. But a sufficient number of teeth is indispensable, otherwise the due effect will not be produced. Their length must not be greater than is necessary, because they will not, on that account, penetrate more deeply into the ground, unless the whole weight is also increased. Lastly, they are to be distributed equally over the frame of the harrow, that one part of it shall not be more interrupted than another by obstacles, and that the greatest possible effect may be produced in pulverizing the surface over which it passes.

Keeping these general principles in view, and applying them to the form and construction of the common rectangular harrow, it will be found exceedingly defective. The form is not such as to secure the teeth to act with regularity over the surface, for some of them either follow in or pass close to the tracks made by others, and a considerable part of the ground passed over in this manner will have escaped the action of the teeth altogether. The manner in which their parts are joined together, also admits of improvement, as it often increases the labour of draught, without in a corresponding degree acting upon and reducing the soil.

To remedy these defects, the common angular harrow has been constructed; and it is one of the most perfect implements of the kind in use. It consists of two parts, joined together by iron rods, having hasps and hooks. Each part consists of four bars of wood, technically termed bulls, connected together by an equal number of cross-bars of smaller dimensions, mortised through them. The former of these bars may be two and a half inches in width, by three in depth; and the latter, two inches in width, by one in depth. The longer bars are inclined at a certain angle to the shorter, so as to form a rhomboid, and they have inserted into them the teeth, which are placed at equal distances from each other. The inclination of the bars is made to be such, that perpendiculars falling from each of the teeth upon a line drawn at right angles to that of the harrow's motion, shall divide the space over which the instrument passes into equal parts. In this case the greatest effect is produced.

The ground passed over is equally indented by the teeth of the harrow, and two or more of them do not pass along or adjacent to the same track.

Fig. 7.



The number of teeth in each of the bulls is seen to be five, and there are consequently forty in the harrow. They project about seven or eight inches below the under side of the frame of the harrow; and it is to be observed, that the length of the teeth shall increase somewhat from the hindmost to the foremost rows.

The iron rods, serving as a joint to the instrument, may pass through two of the bars on each side of the joining only, but it is better that they pass through the entire framework, to give additional strength to the harrow. They keep the two sides of the harrow at the required distance, and the hinges admit of either side rising or falling, according to the inequalities of the surface of the ground.

To enable the horses to be attached in such a manner that each of them may have an equal portion of the draught, there are plates of iron passing through the left-hand bars of each of the sides, with holes in them, so that the line of draught may be shifted to the right or to the left, as may be necessary. The point to which the moving power is attached is seen to be the connexion of the drag of the harrows with the foot-tree, as at P, and this point it is of importance to ascertain in practice. Were a perpendicular to fall from it to the line to which the several perpendiculars from the teeth are drawn, the point of intersection would be in the centre of the entire breadth covered by the harrow, and an equal number of teeth would be on either side. But the larger bars being placed in an oblique direction to that of the harrow's motion, when any obstacle, raising above the surface of the ground, strikes one of these bars, it tends to press it to the right-hand side. To counteract this tendency which the harrow has to be driven to one side, the line of draught should not be directly in the centre of the space covered by the harrow, but placed somewhat to the left hand.

The harrow described is that calculated for covering the seeds of corn crops, and reducing the land after the several ploughings in preparing it for green crops; but sometimes a kind of light harrow is used for covering the smaller seeds, as those of the clovers and grasses. The only difference between it and the larger harrow, consists in the difference of dimensions, both being formed upon principles precisely similar.*

The operation of the harrow is simple. The person driving the horses walks behind the harrow, and by means of the reins, he guides the animals, and urges them forward. He is also to be ready at all times to lift up the harrow when it is impeded in its progress. When he neglects to assist the harrow over any obstacle, it is carried along between the teeth of the instrument, and usually displaces the soil in its course to the depth to which the teeth have penetrated, by which an unsightly appearance is produced on the ridge.

In the operation of harrowing, the harrow passes both longitudinally and across, except in some particular instances, On reaching the end of the field, it is turned round by the horses, and generally passes again over the same ground in the contrary direction; in which case, the land is said to have received a double turn of the harrows, and sometimes several double turns are found necessary. It is found that the action of the harrow, in pulverizing the surface, is facilitated by giving the double turns in different directions. Thus, when a double turn has been given in a longitudinal direction. the next may be given in a direction directly transverse, or inclined at a certain angle to the preceding one. In harrowing land ploughed up from grass, the several turns must not cross each other at any considerable angle, for the action of the teeth on furrow-slices of such a degree of tenacity would otherwise overturn and restore them to their original position. This occurs in the case of harrowing in the seeds of a corn crop, on land which had been in grass the preceding season.

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* See Quarterly Journal of Agriculture, vol. i. p. 553.

A certain state of the land, with regard to humidity or dryness, is favourable for the action of the harrow. On all light soils, the operation can be performed at almost any time when the land is not saturated with moisture; but, in the case of the stiffer clays, a certain state, with regard to drought, is indispensable. When such soils are wet, they are much injured both by the action of the harrow, and by the treading of the horses; and, when they are parched with drought, the harrow is equally ineffectual; for although the land, in this case, sustains no injury, it is turned up in impenetrable masses on which the instrument can have no effect.

The pace at which the animals move forward has a considerable influence over the operation of the harrow. When the land is difficult to reduce to the required tilth, the horses should be made to go as fast as they can walk, the effect depending, in a great degree, on the velocity with which they move. It is this quick rate of motion, and the sinking of the animals' feet in the soft ground, that render the operation of harrowing so excessively fatiguing to the horses. The space of ground that should be passed over in a day by a pair of horses, is about twelve acres.

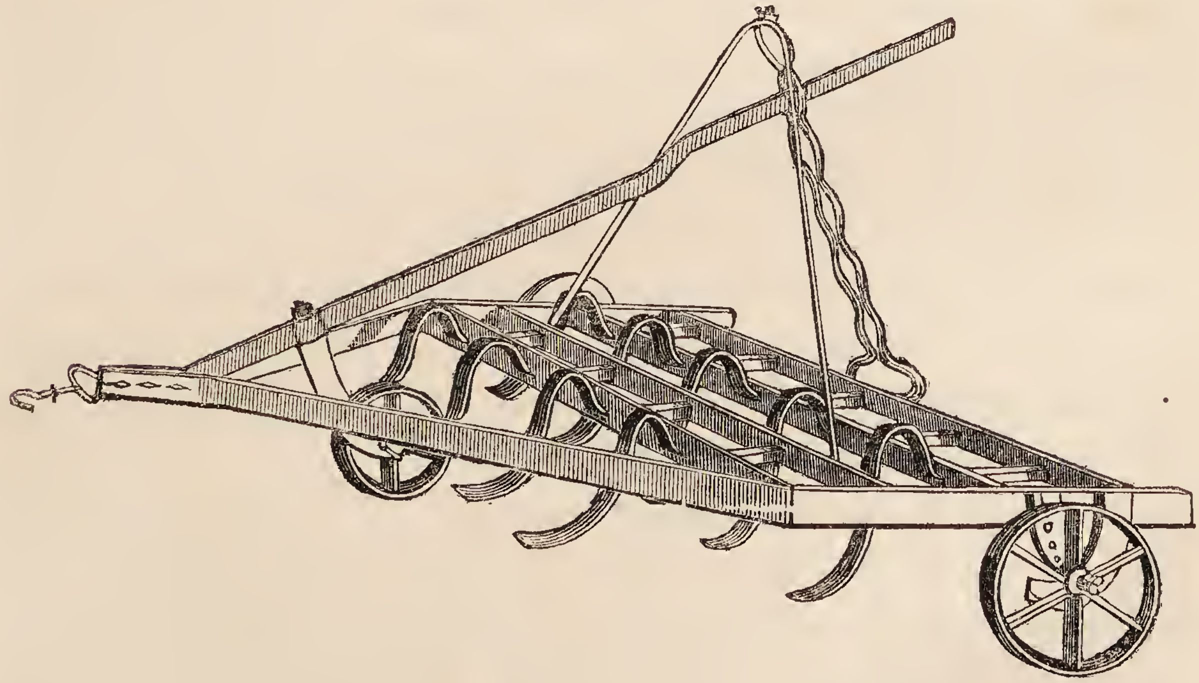
3. *The Grubber.*

In considering the mode of action of the harrow, it has been seen that it is not well adapted for bringing root-weeds to the surface. The teeth of the harrow, being forced into the ground solely by the weight of the instrument, are not well calculated for penetrating into it, and are constantly thrown out by the obstacles they encounter in their progress. In soil which is in any degree tenacious, therefore, the impression made by the teeth of the the harrow is often seen to be extremely superficial. Were the teeth formed somewhat in the manner of the coulter of a plough, they would better insinuate themselves into the ground, and be less liable to be forced out of it by obstacles. But the harrow, from its nature, does not admit of this construction; for, in this case, the teeth would form an angle with the framework in which they are set, and the weeds and rubbish dragged from the ground would be collected at this angle, and would thus be carried along with the harrow.

These are great and palpable defects in the construction of the harrow, which it does not seem probable can be remedied by any attention, or improvement of the instrument itself. But, to obviate these defects, a class of instruments has been employed, intermediate in their manner of operation between the harrow and the plough, and partaking more of the properties of the former than of the latter—termed grubbers or cultivators. These instruments, in their improved form, are of more recent introduction into agriculture than either the plough or the harrow.

Perhaps the most valuable instrument of this class is that termed Finlayson's harrow, from the name of its inventor, Mr. John Finlayson of Muirkirk, in Scotland. It is formed wholly of iron, and consists of two parallel sides, with two sets of transverse bars, as shown in the figure. Into the hindmost of these sets of bars are inserted five teeth, and in the foremost set, four. A little before the foremost set of teeth the sides of the frame begin to converge to a point, where they are attached by a bolt to a spring, forming the point of draught, and a lever, by which the depth at which the instrument is to be worked is regulated. On the hindmost transverse bar is an upright

Fig. 8.



lateral spring, consisting of two rods, forming openings, and supported in the manner shown in the figure. The handle, which is retained in its place in the openings of the spring, may be forced up and down by pressing it; and, as the handle and the forewheel are joined together, by raising the handle the forewheel will be raised also, and the teeth allowed to go deeper into the ground. When the handle is depressed and placed at the bottom of the spring, the foremost teeth are then lifted out of the ground; and in proportion as the handle is forced up into each successive opening, the teeth descend, until the handle arrives at the top, when they will be between eight and nine inches in the ground, which is the greatest depth that is necessary to set them. The facility with which the instrument can be raised or lowered adds greatly to its value. The axles of the hinder wheels may be elevated or depressed by means of an apparatus attached to the side bar, and thus the hinder teeth are made to correspond in depth with those in front. The space covered by the teeth is five feet four inches, and the length of the teeth is twenty-nine inches. The weight of the whole instrument is about four cwt.

It will be readily conceived, that an instrument of this form, when worked to the depth to which it is capable of penetrating, must not only have a very powerful effect in pulverizing very strong tenacious soils, but must also be far superior to the common harrow, or any other instrument, in the eradication of weeds. The introduction of the grubber, therefore, as an agricultural implement, must be regarded as beneficial and important. It is highly useful in assisting the operations in the preparation of the land for fallow crops. When land is full of root-weeds, the repeated operation of the plough, the harrow, and the roller, is the method resorted to for tilling and cleaning it; but, very frequently, when the land is stiff, even the operation of ploughing itself tends to compress the furrow-slice, and, if the influence of the sun be considerable, it will be formed into a hard mass, on which the subsequent operations of the harrow and the roller will have little effect. But, by means of the grubber, such land may be tilled and cleaned without difficulty, as there is no necessity for turning up a fresh surface. The instrument, too, can be made to go to any depth in the soil that may be required, and thus the land can either be loosened to the depth to which it had been previously ploughed, or to such a depth as may be most suitable for the purpose intended, whether that purpose be to clean the land of root-weeds, or merely to loosen it a few inches deep.*

In the operation of the grubber, it is frequently found expedient to go twice over the ground; in this case, it is proper to set the teeth at half the depth required, in the first operation, and, in going over the ground a second time, to set them at the full depth, always observing to give the second turn in a direction crossing the first. This, with a few turns afterwards of the harrow, will constitute a very efficient tillage.

In land in any degree tenacious, four horses are required for the grubber, but in all the lighter soils, it may be worked with facility by three. In using the instrument, the workman walks behind, and regulates the lever or handle. He depresses it when the grubber is to be turned round, by which it is almost raised out of the soil, and as soon as it is completely turned round, and the horses ready to move forward, he elevates the handle to allow the teeth to penetrate to their former depth.

The grubber, with three horses, will go over from six to seven acres a day, so that the expense of one operation is nearly equal to one-fourth of that of the plough, and three times that of the harrow.

A smaller and lighter form of the instrument is sometimes used, which, instead of nine teeth, contains only seven, and is usually worked with two horses, or, in the case of heavy soils, with three. With the exception of the difference in dimensions, it is similar to that which has been described. The space covered by it is four feet.

4. *The Roller.*

The roller is used to break the clods turned up by the plough, and to compress the earth and smooth the surface of the ground. For tillage lands it is used to break the lumps of earth, and in some cases to consolidate the ground about newly-sown seeds; on grass lands, it is used to compress and smooth the surface, and render it better adapted for the action of the scythe.

The roller is constructed of wood, stone, or cast iron, according to convenience. That chiefly employed is a solid cylinder of wood, or a hollow cylinder of cast iron, surmounted by a strong framework, having shafts in which the animal of draught is placed. It has been a matter of dispute, whether rollers with large or small diameters have the advantage in point of effect upon the land. It appears, however, that by increasing the diameter, the effect is diminished, for the same weight is then supported by a greater space, therefore the diameter should always be in proportion to the weight of the cylinder. The common length of rollers is from five to six feet, and the ordinary diameter from twenty to thirty inches.

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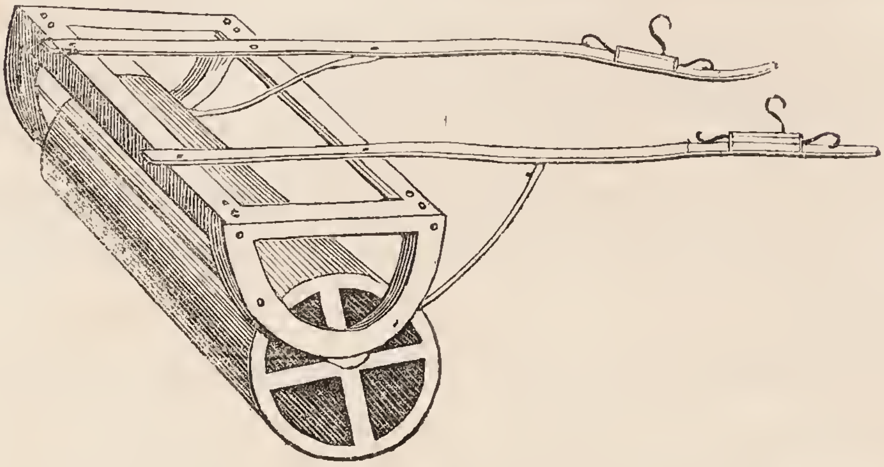
* Quarterly Journal of Agriculture, vol. ii. p. 843.

Fig. 9.



Considerable inconvenience has been experienced in the use of the common roller when turning at the side of the field; for the cylinder, not moving upon its axis, but, being drawn along the surface of the ground, is liable to make depressions and tear it up before it comes again into the direct line of draught; and, at the same time, the labour in turning it round is fatiguing to the animal employed in working it. To remedy this, the cylinder should be divided into two parts, so that each part may revolve separately, and, in turning, one of them can move forward, while the other is taking a retrograde direction.

To the framework of the roller it is usual to append a box in which stones are placed to increase the weight, and consequently the effect upon the ground; but this object is better accomplished by increasing the weight of the cylinder itself than by placing any weight upon the frame.

When the roller is employed as an auxiliary in the preparation of land for fallow crops, it succeeds the harrow, by which the clods or indurated masses of the soil have been brought to the surface. These the roller bruises by its weight in passing over them; and by this means the harrow is enabled to act upon these clods, upon which it would otherwise have produced no effect.

When the roller is employed in smoothing the surface of grass land, it is drawn across the ridges, and this precaution is to be observed in all cases in which land in ridges is to be rolled.

One horse is usually sufficient in the operation of rolling, but when the roller is heavy, or the surface of the land to be rolled uneven, two may be required. The quantity of land which can be got over by the roller in a day is about six acres.

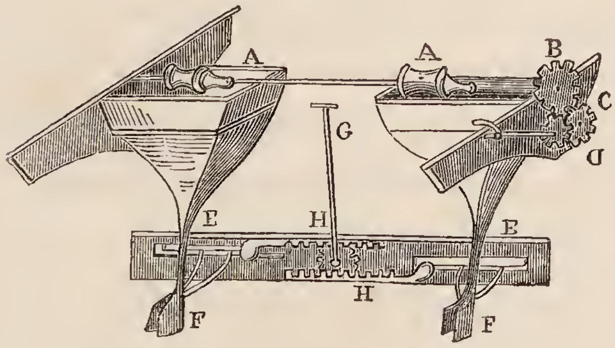
II.—MACHINES FOR SOWING.

1. *Machines for sowing the Seeds of Turnips, Rape, &c.*

The small seeds of the turnip and other plants of the brassica tribe are sown equally and expeditiously by means of a peculiar class of machines, which are made either to be drawn by a horse, or pushed forward by a man, walking between the ridgelets or drills. The machine drawn by a horse sows two drills at each turn, and performs the work with greater regularity than can be effected with the hand machine.

In this machine the seeds are put into cylindrical boxes of iron or tin, which are made to revolve during the time the machine is in motion, and being perforated in a line all round, the seeds fall through as the boxes revolve. Funnels are placed below each of these boxes, the upper part of which embraces the boxes, and through these the seeds are carried to the ground in tubes defended at their lower part by coulters, which make ruts in the ground into which the seeds fall.

Fig. 10.



The construction of this machine is represented in *Fig.* 10. Here the hollow cylinders or seed boxes A A, are seen to be put in motion by the pinion at B, to which motion is communicated as the machine moves forward. The intermediate pinion C, being put in motion by that at B, in its turn gives motion to the pinion D, upon the axle of which the cylinders are placed; and the cylinders being perforated with holes all round, the seeds fall as they revolve. The seeds are put into the cylinders by means of apertures, which have sliding lids to close them while the machine is in motion. The tubes E E, convey the seeds from the cylinder to the ground, and they are defended by the hollow coulters F F, which also make ruts along the top of the drill in moving forward, into which the seeds fall. These coulters are placed at a greater or smaller distance from each other, by means of the lever and toothed wheel G, acting on the iron plates H H.

The machine moves forward on a large wooden roller, which compresses the top of the drill and pulverizes it before receiving the seed. The ruts made by the coulters F F, are filled up by two small rollers attached to the machine behind, which thus cover the seed. Handles are fixed to the coulters, by means of which the workman is enabled to raise either of them up when impeded by obstacles in the way.

The hand machine, which sows only one drill at each turn, is formed on precisely similar principles. It is attached to a small wooden roller drawn by one horse, and while the roller compresses the drill previous to the seed being sown, it covers in that sown at the last turn at the same time.

In working the machine figured above, a man and horse are required. The man remains behind to ascertain that the tubes are not obstructed by lumps of earth or manure torn up from the drills, and also to see that nothing is out of order about the machine.

2. *Machines for sowing the Seeds of the Bean and Pea.*

The seeds of the bean and pea are either sown by the hand or by machinery. The bean being chiefly cultivated in drills, the seeds are appropriately sown by a machine; but those of the pea being generally sown broadcast, are conveniently distributed over the ground by the hand. Even when the crop is cultivated according to the drill system, no disadvantage attends the sowing by the hand; but greater regularity and precision are attained when machines are employed.

In the construction of machines for this purpose, the principle adopted is, placing a grooved cylinder in the bottom of a box made to contain the seeds, and this cylinder revolving in proportion as the machine moves forward, a quantity of seeds falls through, dependant upon the size of the grooves; and these are conveyed to the ground by means of tubes. When the machine is made to be moved by the hand it sows only one drill at each turn; but when drawn by a horse it may be made to sow two or four, the horse in each case walking in the centre drill.

III.—IMPLEMENTS FOR HOEING.

The harrow and grubber have been seen to effect the complete pulverization of the soil, and the eradication of weeds, when combined. These purposes they accomplish in so perfect a manner as to render the employment of additional implements or machines unnecessary; but in certain situations they are altogether inadmissible, and then other implements must be used for the purpose.

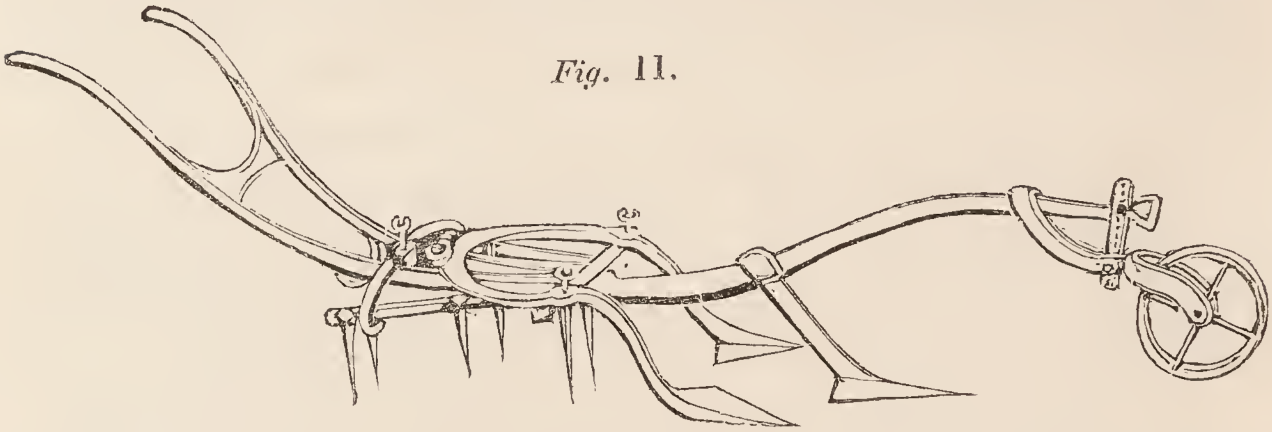
The cases in which the harrow and the grubber are inadmissible, are for tilling and pulverizing the intervals of plants which are cultivated in rows. These are the various plants which are included under the denomination of green crops, as is to be afterwards explained.

A hoeing instrument of general use and great utility is a common plough, formed on the principles already described, but of a smaller size, and drawn by one horse. In using this plough the horse walks in the interval between the rows of plants, and the plane of the left-hand side of the plough is made to go as near the line of plants as can be done without injury; and in this manner a slice is cut off from the side of the drill, and laid in the interval. The same operation is performed with the adjoining row, by which another slice is cut off, and these two being thrown together in the centre of the interval, are further acted upon and reduced by some of the other implements which are to follow.

When this species of tillage is employed, the implement, which is further to reduce the slices thus pared from the drills, is usually formed with beam and handles like a plough. To the beam wings are attached, which are so constructed as to expand and contract according to the width of the intervals in which they are to be employed. In these wings a certain number of teeth is inserted, varying according to the nature of the soil, and these, following the plough, reduce the earth turned up by that implement.

But machines have been constructed to perform both these operations simultaneously; that is, a slice of earth is first pared off from each side of the drill, and then pulverized by another part of the instrument. With this view the implement represented in *Fig.* 11, has been constructed. It is intended to be introduced between the drills as soon as the plants appear above ground, and the operation is repeated at intervals, until the crop is thoroughly cleaned. The centre hoe is stationary, acting on the centre of the interval, and the right and left expand and contract in the manner mentioned. The depth is regulated by the wheel at the point of the beam, and may be varied from one to six inches. The hoes cut the bottom of the space between the drills completely, while the harrow, following, pulverizes the soil, and rakes out the weeds. Should circumstances require, the wings of the harrow may be taken off, and the hoes only used; or the hoes displaced, and the harrow only employed. The manner of using it presents little difficulty. Two horses are generally required to work it.

Fig. 11.



Several instruments of the hoe kind are constructed in such a manner that the hoeing apparatus may be altogether removed, and two mould-boards substituted, in which case a double mould-board plough is formed. Even the plough of smaller dimensions, which has been referred to as a hoeing instrument, is sometimes made so that the side-plate may be removed, and another mould-board added; or that both the side-plate and mould-board may be taken off, and wings substituted containing hoes or teeth, as the case may be.

IV.—MACHINES FOR THRASHING AND PREPARING GRAIN.

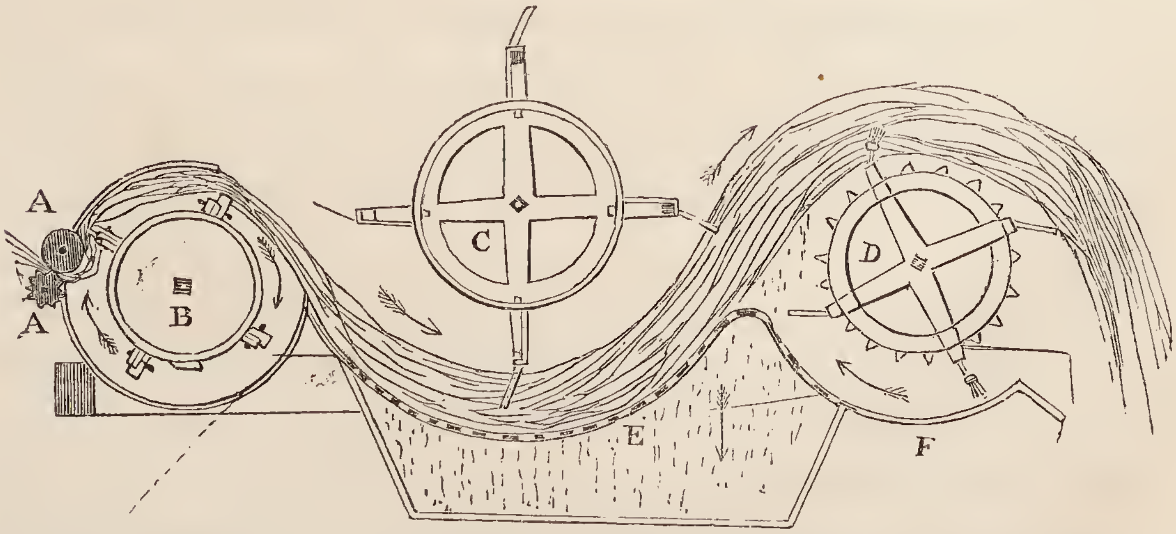
1. *The Thrashing Machine.*

The separation of the grain from the straw constitutes an important part of the labours of the farm, and the proper execution of it is attended by numerous advantages. Until the invention of the thrashing machine, however, it was very imperfectly performed, and frequently at a very considerable expense; but by the assistance of machinery, that which before occupied weeks to perform, is now done in as many hours, and executed in a superior manner.

The construction of the thrashing machine necessarily belongs to a particular class of mechanists; but still it is well that the farmer should understand the principle of its construction, by which he will be better able to direct the operation of the machine, and perceive the cause of any accident or obstruction that may take place. Thrashing machines are of various forms, but the principle of operation is the same in all, the difference being in the arrangement of the minor parts. In all cases, the unthrashed grain is made to pass between two revolving rollers; and these, being of small diameter compared with other parts of the machinery, revolve with comparative slowness, while the grain thus held is acted on by beaters placed upon a cylinder which revolves with great rapidity. By the action of these beaters the corn and chaff are detached from the straw, and then, by means of revolving rakes, the straw is shaken, and the corn and chaff separated from it.

The operation of the thrashing machine will be better understood by a reference to the annexed figure, which represents a transverse section of the parts mentioned. The unthrashed corn is seen to pass through between the revolving rollers A A, the lower one of

Fig. 12.



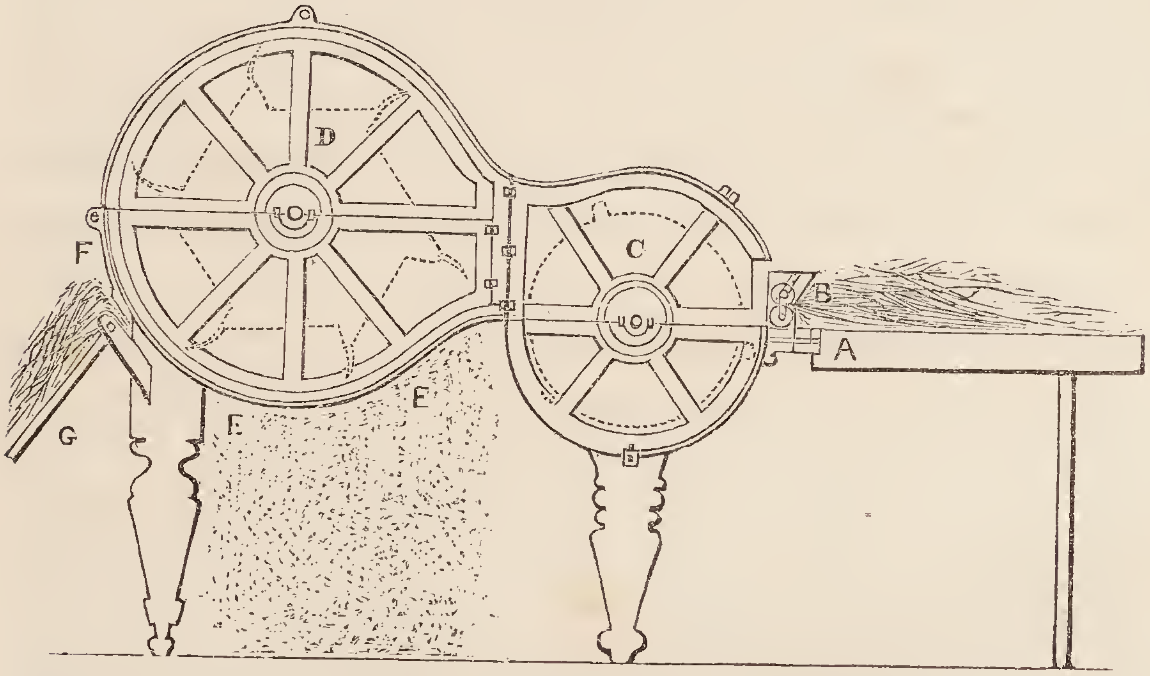
which is fluted, and the upper one plain. B is the cylinder upon which the beaters are fixed, and it is placed so close to the rollers that the beaters shall act upon the corn while it is yet retained by them. This cylinder is made to revolve with great rapidity, compared with the motion of the other parts, by which the effect of the beaters is increased. By the motion of the cylinder B, the whole is thrown forwards towards the other parts of the machinery, to be further acted upon by rakes placed upon the cylinders C and D, which separate the straw from the grain and chaff, and throw it out of the machine in the manner shown in the figure. The bottom of the machine E is formed of spars to admit the grain to pass through while the straw is carried forward by the shakers. Brushes may be appended to the rakes, which sweep back any of the grain which may have fallen into the hollow part F, so that all may pass through the sparred bottom E. Such is the principle of the thrashing machine, and the manner in which the operation of thrashing is performed.

The manner in which the grain is thrashed by machinery will now be fully understood from the preceding diagram and description. The machinery of which a section has been seen is that of the larger kind, requiring from four to six hours to keep it in motion; and although it performs the operation both expeditiously and effectively, it is unsuited to the smaller class of farms, from the outlay in the first instance being so large, and the force afterwards required to work it being great.

To remedy the inconvenience, machines of various constructions, capable of being kept in motion by a small force, have from time to time appeared. Some of them have been made to be worked by hand, but it is conceived that nothing, in an economical point of view, can be gained from the use of those over the common method of thrashing by the flail. An effective machine, however, has been constructed, which can be worked by two horses; and it performs the work in a satisfactory manner, both as regarding economy and expedition.

A machine of this description is represented by the accompanying figure. The unthrashed grain is here placed on the feeding-board A, and being gently pushed forward, it is caught by the revolving rollers at B. C is the thrashing drum or cylinder upon which the beaters are fixed; and it is placed so close to the feeding rollers that no part of the grain can escape the action of the beaters, which revolve with great rapidity. On passing from the thrashing drum the whole is caught by the teeth of the rakes on the shaker D, and while the straw is carried forward the grain is separated from it, and falls through the bottom of the machine at E E. By the action of the shaker D, the straw is thrown out of the machine at F, upon a second shaker G, which consists of a large rake moving rapidly up and down. Here any loose grain that may have been carried along with the straw is separated from it, and falls through the spaces between the rods in the shaker G, while the straw is still thrown forward, to be removed by one of the attendants. This machine is constructed entirely of cast iron, and will thrash from three to four tons of grain in twelve hours.*

Fig. 13.



The machinery is put in motion by animal power, by water, or by steam, variously applied. In the greater number of cases the thrashing machine is driven by horses, this power being available in every case ; but, when other means can be used, horses should not be employed for the purpose, the labour being severe, and the time thus occupied being taken from that for performing the other labours of the farm. Water is always to be preferred when it is available, as being the most economical power which can be applied.

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* Thrashing machines of this description are manufactured at the Soho Foundry, Belfast, under the inspection of Messrs. James M'Adam and Co., in a very superior manner. Through the kindness of these gentlemen we have been furnished with the preceding sketch and description, as well as sketches of several of the succeeding implements and machines which appear in this section. It gives us great pleasure in being able to inform the agriculturists of the North of Ireland, that such an establishment is in the country as that of the Messrs. M'Adam in Belfast, and we feel assured, after a careful personal inspection, that all the improved agricultural implements and machinery in use in the most improved districts of England and Scotland may be procured at their establishment, manufactured in the best manner.

Whatever be the nature of the power employed, it should be made to act with an equal force throughout the whole operation. In commencing, the power should be applied with caution. A great and rapid force, produced instantaneously, is apt to strain some weaker part of the machinery, or otherwise injure the machine. In the machine which is represented in our drawing, an ingenious contrivance is introduced, by which all danger of breakage is prevented in case of a horse becoming unmanageable, or backing suddenly during the operation of thrashing. This is effected in a simple manner by means of a wheel and spring, which relieve the machinery from the strain of the sudden check, otherwise produced by starting or stopping suddenly. A full velocity of the machinery should be produced before any corn is put in, and the corn is afterwards to be supplied in regular quantities, proportioned to the amount of work which the machine is calculated to perform. In supplying the corn, some dexterity is requisite. One sheaf at a time is sufficient for most machines, and for those of the smaller class the sheaf must be divided. No more should be presented than what can pass through the machine without in the least degree retarding its velocity. A velocity which permits the feeder to count the strokes is too slow, and conveys the idea of the machine being fatigued, and likely to be overcome; and in this case much of the corn passes through in which the grain is imperfectly separated from the straw. Oats with long straw, in rather a damp state, is the most apt to produce this retarding effect. When the straw of the oats is damp, it sometimes becomes wrapped round the upper feeding roller, in which case it is to be removed by cutting it in pieces with a large knife, which should be convenient.

In supplying the corn to the machine, it should be spread evenly on the feeding-board which is placed before the rollers. Should any part of the sheaf be thicker than another, the upper feeding-roller will be elevated by it in passing through, and the pressure then being removed off the thinner part, it will pass the beaters without being properly thrashed. To prevent interruption in the process, the sheaves are handed to the person supplying the corn to the machine, having been previously loosed, and the band spread along in the direction of the other corn. The person who stands at the feeding-board takes the unthrashed corn from the table, and spreads it upon the board, pressing it forwards towards the rollers. His duty is to convey it in due quantity to the machine; and, generally, to observe, that all is right with regard to the machinery. Two other persons, generally females, are employed—one to remove the straw, and the other the grain as it is thrashed.

A winnowing apparatus is usually attached to the thrashing machine for completing the preparation of the grain. In this case the winnowing machine is placed under the thrashing machine, and the grain after being thrashed is received by a set of moving riddles, which separates the small straws and other grosser impurities, and it then falls into the winnowing machine below, where the cleaning process is completed by the separation of the chaff. Formerly, when all these operations were performed at once, four horses were necessary for keeping the machinery in motion; but the different parts have now been so simplified that two horses will be sufficient.

2. *The Winnowing Machine.*

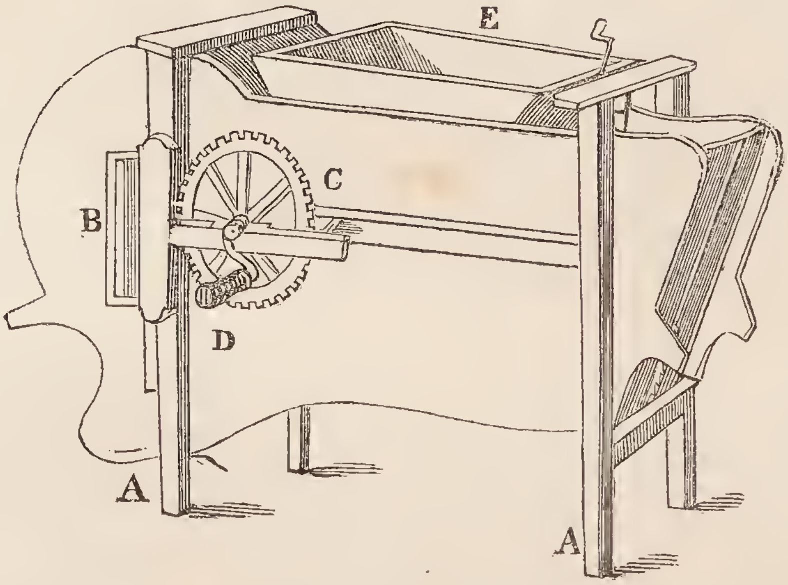
The winnowing machine, it has been said, is sometimes attached to the thrashing machine, and winnows the grain as it is separated from the straw. In this case, the machine is put in motion by the power which operates on the thrashing machine, and hence the saving of labour resulting from that arrangement; but in the case of the flail being used in thrashing the grain, it is winnowed by hand labour.

The objects accomplished by the winnowing machine are the removal of the husks or chaff of the corn from the grain, and the separation of the impurities intermixed. The manner in which these were formerly effected was sufficiently tedious and imperfect. The grain was either let fall from riddles between the doors of the barn, or carried out to some eminence, there to undergo the same process; but, in either case it was indispensable that the wind should have a certain velocity, and this often caused the operation to be delayed beyond the proper season. By an improved winnowing apparatus, the work is performed in a superior manner, and at any time that may be convenient.

In the construction of the winnowing machine, certain peculiarities of form are given to it, according to the taste of the mechanist, but the principle of action in all remains the same. Four or more oblong boards of wood are fixed at equal distances from each other, upon an axle placed horizontally, and extending through the machine. This axle is driven round by a wheel acting upon a pinion, so that a rapid rotary motion is given to the boards, and a current of air is thus produced, in the course of which the grain to be winnowed is made to fall from the hopper. By the intervention of a sieve kept in a lateral motion the grain is scattered in the current, by which the chaff and other matters are separated from it.

In the description of the several parts of the winnowing machine, a greater degree of minuteness of detail may be necessary than in the case of the thrashing machine, as the former is in more general use, and being often constructed by country mechanics, it is frequently of a defective form. A A, *Fig.* 14, are two standards which are fastened longitudinally together by a rail, and joined transversely to corresponding standards in the opposite side. A frame is thus produced, upon which the rest of the implement is constructed. This frame is lined inside of the standards, on both sides, with boards.

Fig. 14.



Through these boards there is an aperture at B, by which air is admitted to supply the current produced within the machine. A corresponding aperture is made in the opposite side, and these openings may either be enlarged or diminished by means of sliding boards, so that a large or small quantity of air can be admitted. C is the large wheel to which motion is communicated, by means of the handle D, and this wheel, acting upon the pinion of the horizontal axle, passing through the machine, communicates motion to it, and by the boards placed on this axle, the current of air is produced which winnows the grain.

V.—MACHINES FOR PREPARING FOOD FOR LIVE STOCK.

1. *The Turnip Slicer.*

The turnip is chiefly used as food for cattle and sheep, but it is sometimes given to horses. Though it is common to give the turnip to these animals in an entire state, it is found to be beneficial also to give it in other states.

When turnips are given to horses, they are frequently boiled or steamed; but when given in a raw state, they should be cut into slices. Various instruments have been constructed for slicing turnips. One consisting of a hopper and fly-wheel, set upon a frame, is the most expeditious in its operation. The area of the wheel is covered with wood; and there are two cutting-knives, each nearly of the same length as the radius of the circle, placed on opposite sides of the centre, in such a manner as nearly to divide the circle into two equal parts. The hopper is so placed, that the turnips put into it shall always, at its under side, press against the wheel. At every revolution of the wheel the knives cut slices from the turnips pressing against them; and an aperture is made through the entire wheel corresponding with, and of the length of each knife, so that when the slice is cut off, it passes through this aperture, and falls down on the other side of the wheel, into a box or basket placed to receive it. The annexed figure is a representation of this machine.

Fig. 15.

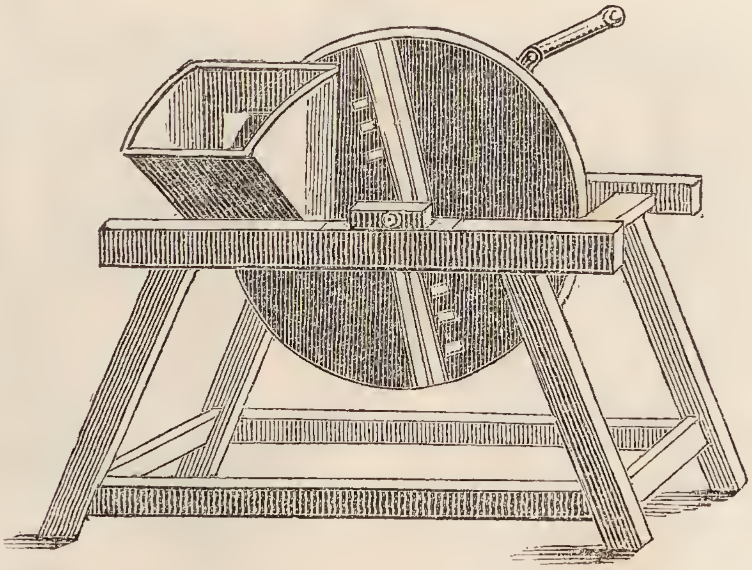
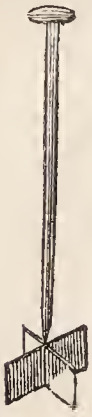


Fig. 16.

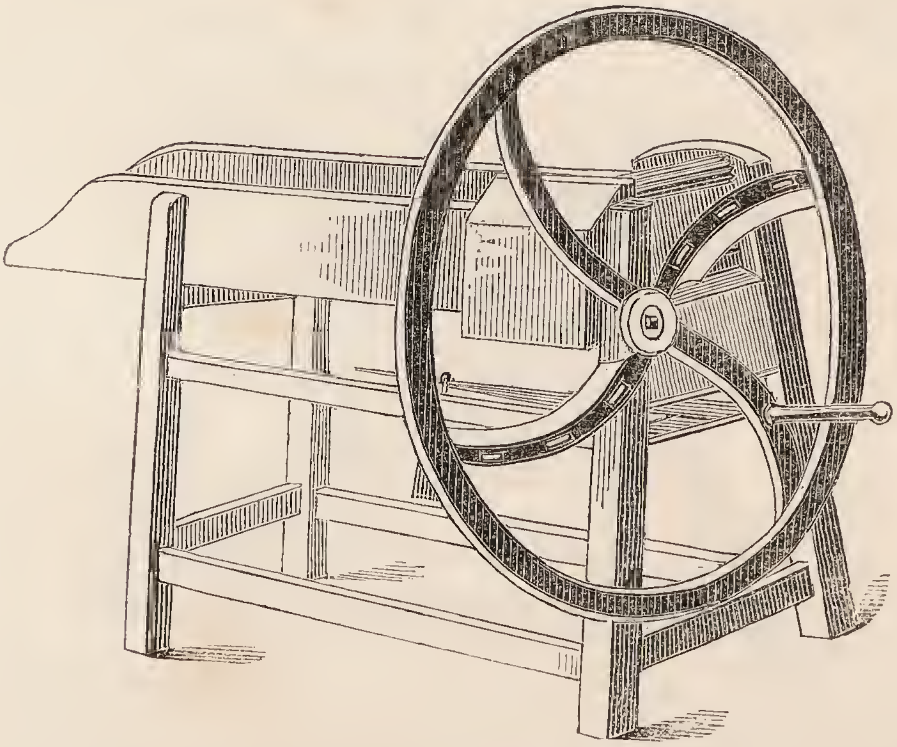


Turnips and other roots are also sliced with expedition by another simple and easily-constructed instrument. It is sometimes constructed in the form of a cross hoe, with prongs on one side; and in this case, the prongs raise the turnip out of the ground, after which the other side cuts it into several pieces. But perhaps a preferable construction is that represented in *Fig.* 16. The chopper, by a single operation, cuts the turnip into four parts, and this size will in general be found sufficiently small; but when it is not so, the parts can again be subdivided by a similar operation. The process of subdividing turnips in this manner is both simple and expeditious. The angular form of the turnip, too, is found best for being easily taken into the mouth of cattle.

2. *The Straw Cutter.*

It has been found that, in certain cases, straw and hay can be much more profitably consumed as food when cut into pieces of a given length, and combined in various proportions with other matters; and to effect this object, a machine termed a straw-cutter is employed.

Fig. 17.



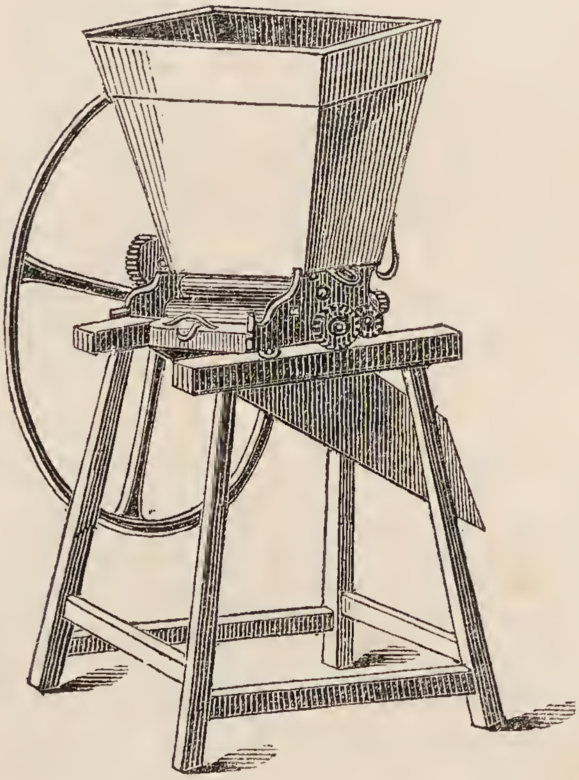
The principle of construction in this machine somewhat resembles that of the thrashing machine. As in the case of that machine the straw or hay is placed between two revolving rollers by which it is firmly held in passing through. Instead of being then acted upon by beaters, it is acted upon by knives which strike off a portion of the straw or hay of from half an inch to an inch in length, according as the machine is adjusted.

Fig. 17 represents a two knived straw cutting machine with which a man and boy can cut as much straw or hay in the working hours of a day, as ten head of cattle can consume in a week.

3. *Machine for bruising Grain.*

A machine is used occasionally for bruising grain, intended for the food of animals, by which the mastication is rendered more perfect, and the whole of the nutriment contained in the seeds is rendered available for the support of the animals. This has been found a great improvement in the feeding of horses, in particular, and the practice is worthy of imitation. The construction of a machine for this purpose is exceedingly simple. Two rollers of nearly equal diameters are placed adjacent to each other, the convex surface of each being slightly fluted, and the seeds are placed in a hopper above these rollers, and are bruised in the passage through between them. By an additional pinion, the rollers turn in contrary directions, and this arrangement causes the grain to be carried rapidly through them. They are so placed that, by means of screws, the distance between them may be increased or diminished, according to the size of the seeds to be bruised.

Fig. 18.



This machine is usually driven by the hand, but, in this case, the operation of bruising grain is a work of labour. A better arrangement is, that it should be done by the power attached to the thrashing machine, especially when that is water or steam, and this is equally applicable in the case of the straw-cutter, as in that of the machine for bruising grain. The machine here figured will bruise a stone of oats in ten minutes.

VI.—IMPLEMENTS OF CONVEYANCE.

The implements of conveyance on the farm are the single-horse carts, with various appendages, according to the nature of the article of transport. They are superior to the waggon in the expedition with which the work is executed by them, and also to the car in general use in some parts of Ireland, inasmuch as that a certain amount of work can be performed with the cart with less exertion being required on the part of the animal of draught.

In cases where the work to be performed is carried along good roads, and the labour in loading and unloading is inconsiderable, when compared to the distance to which the load is to be conveyed, the waggon may sometimes claim a preference; but, even in these cases, the single-horse cart might be used with advantage—a fact which is attested by the circumstance that it is coming into more general use, even in districts in which waggons had previously been almost universal. It admits of demonstration, that a horse can move a greater weight when part of it is to be carried and part dragged along, than when it is to be pulled altogether, and this is the manner in which the animal acts in the cart, a part of the weight being then placed upon his back.

To insure facility in discharging the load, the cart is frequently made that it can be turned up without taking the shafts off the horse, in which case it is termed a turn-up cart. In this case the body of the cart turns upon the axle, and being attached to the shafts by a hook or bar in front, it is turned up by disengaging this hook, by which the load is thrown off, the horse still remaining in the shafts. When the body is fixed to the shafts then the horse must be disengaged from the shafts; and this is the plan of construction adopted in carts for long journeys. For farm purposes the turn-up cart is to be preferred.

In the construction of carts, it is indispensable that the materials employed should be of the best description, and that the workmanship should be executed in a style combining lightness and neatness with utility. These implements being subject to various injuries from the nature of the work which is to be performed with them, it is the more necessary that their construction should be the most perfect that can be attained.

For ordinary farm labour, an apparatus is fixed upon the body of the cart, about a foot in height, and extending all round it, with a view of preventing any substances that may be placed on it from falling off. In this case the hinder board is made detached, for the purpose of allowing the load to be easily discharged, or placing it with greater facility in the cart. Two boards removable at pleasure are also placed upon the edge of each side, for the purpose of better supporting the load when composed of bulky materials. They are fixed by long handles passing through iron staples on the outside of the framework. These side-boards are found very serviceable in the cartage of such bulky materials as hay and oats during harvest.

VII.—IMPLEMENTS OF MANUAL LABOUR.

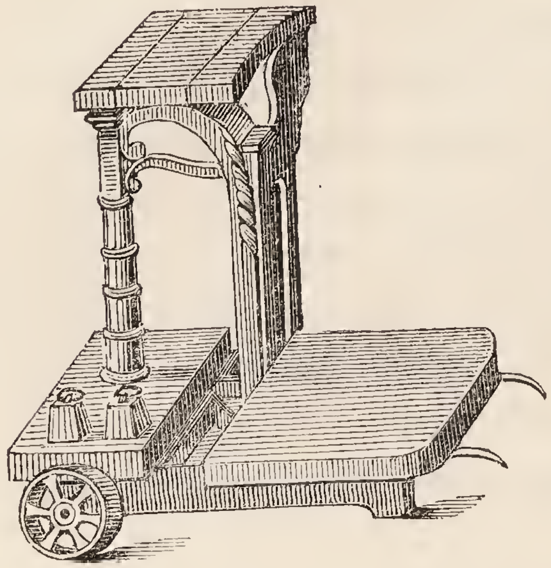
Weighing Machines.

Among the implements of manual labour may be enumerated a weighing machine, or apparatus for ascertaining the weight of different articles, as being indispensable upon a farm. The various articles of farm produce are to be weighed previous to their being sent to market, or stored up for use, otherwise a correct account of the returns cannot be made out. A weighing apparatus is also essential in the feeding of cattle, as, by the use of it, the farmer is enabled to ascertain the quantity of flesh which is gained in proportion to the amount of food consumed; and he can also ascertain the relative fattening qualities of his cattle, when those making the least progress are soonest to be disposed of, and their place supplied by more profitable animals. And, further, having ascertained the proportion between the live and the dead weight, he is enabled to determine with precision the value of the animals when taken to market.

The more portable articles of the farm are usually weighed by a set of beam and scales, with the number of weights that may be necessary; but this apparatus being incapable of weighing the more bulky matters, such as loads of different kinds, as well as the several feeding animals, it becomes important to procure a machine calculated for weighing the smaller articles, as well as the larger and more bulky.

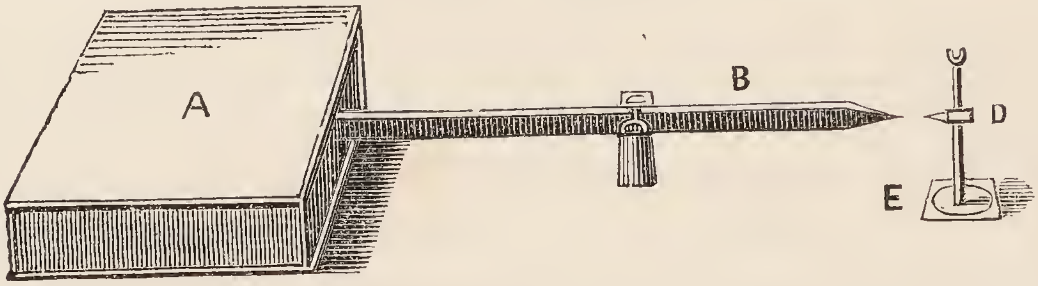
The annexed figure represents a machine adapted for weighing sacks of potatoes, corn, or other articles. It is merely a particular form of the well-known balance. The article to be weighed is placed on the platform on the right hand side, and the weights on the opposite side, as seen in the figure. It is furnished with wheels and handles, which add much to its portability.

Fig 19.



Another very convenient and portable weighing machine is now becoming known to farmers, a sketch of which is seen in *Fig.* 20.

Fig. 20.



It is entirely composed of metal, as in the case of the preceding machine. The lever B is a bar of polished steel, with a sliding weight, the position of which on the lever denotes the weight of the article, the lever being graduated so as to make the weight appear. The lever is so fixed in the box, as to be affected by any pressure placed on the top of the box, A ; and this box being loaded with the article to be weighed, the weight is moved along the lever until the point of the lever is exactly opposite the pointer D, fixed on a stand E, on the same horizontal plane as the box. The position of the weight on the lever thus indicates exactly the weight of the article to be weighed.

When this machine is to be used for weighing sacks or other bulky articles requiring a support, an iron upright back may be appended to it. The great advantages presented by the use of it are its extreme portability, durability, and precision. Two men can easily move about a machine to weigh twelve cwt., and it will denote the weight accurately to a quarter of a pound.

The implements of manual labour used upon the farm are numerous, but most of them are so well known, that it is unnecessary to describe them in this place. Any peculiarities of form or construction will be pointed out when the work in which they are to be employed is being described, and they will be enumerated at length when we come to consider the capital necessary for the farm.

IV.—BUILDINGS OF THE FARM.

A VARIETY of buildings is necessary for carrying on agricultural operations. They are designed to enable the farmer to thrash and prepare the produce of his land for use; to preserve his corn and other seeds; to afford protection and shelter to the different species of live stock; and to prepare and collect manures. To these may be added a house for the accommodation of the farmer and his family; for, although the farm-house cannot be regarded as essential to the successful prosecution of the labours of the farm, it is necessary for the comfort and convenience of those engaged in agriculture as a profession.

In the construction and arrangement of farm buildings very little taste or ingenuity has been evinced in this country, whether we regard those of the occupier of a few acres only, or of those of the occupier of as many hundreds. The character of the buildings of the rural districts of the kingdom has, indeed, afforded a fruitful topic for the display of the descriptive talents of every writer who has turned his attention to the statistics and general condition of the country. Even in the richer and more highly cultivated districts of the sister countries, the improvement of the agricultural edifices does not seem to have kept pace with the rapid strides towards perfection in the cultivation of the soil. Convenience and economy have, in almost every case, been studied to the exclusion of symmetry, or the slightest display of architectural taste; and it is, no doubt, right that this should be the case to a certain extent, utility being of greater importance than an unnecessary display of ornament; but while it must be admitted that symmetry of design and neatness of execution should always be considered as subordinate qualities in the construction of agricultural edifices, yet a certain degree of taste may be evinced without interfering with the most rigid economy; and it will serve as a stimulus to the introduction of a greater degree of taste and neatness among farmers, and essentially contribute to improve the system of agriculture which they practise, and, in this way, improve their general condition.

The acquisition of a superior taste in the construction and arrangement of our dwellings, exercises such a powerful influence in improving the general condition of society, that it may be regarded as essential to the introduction of more industrious habits, and more refined desires among the rural population of Ierland. There is, in fact, a kind of symmetry in the thoughts, feelings and efforts of the human mind. Its taste, intelligence, affections, and conduct, are so intimately related, that no preconcertion can prevent them from being mutually causes and effects. The first thing powerfully operated on, and in its turn proportionally operative, is the taste. The perception of beauty and deformity, of refinement and grossness, of decency and vulgarity, of propriety and indecorum, is the first thing which influences man to attempt an escape from a grovelling brutish character. In most persons this perception is awakened by what may be called the exterior of society, particularly by the style and character of the buildings. Houses deficient in those arrangements which are necessary for the convenience of a civilized and intelligent class of inhabitants, will invariably be occupied by persons of low and grovelling manners and dispositions, despising altogether every thing tending to the cultivation of taste or refinement. This connexion may be seen in almost every district of this country, and it is to be hoped that the landed proprietors and others interested in its improvement will use their influence towards the introduction of a better and more convenient class of houses for its inhabitants, as the first step towards the cultivation of more industrious habits and more refined desires.

The extent and arrangement of the different parts of farm buildings depend on the nature and extent of the farm, and on the species of management to be pursued upon it. They may be conveniently classed into—

1. Buildings as repositories, or for performing in-door operations.
2. Buildings for the accommodation of live-stock.
3. Buildings and enclosures for the collection and preparation of manures.
4. Buildings used as human habitations.

These shall be described separately in the first place, and afterwards in combination, in which case they constitute what is termed the farmery.

I.—BUILDINGS USED AS REPOSITORIES.

1. *The Barn.*

On tillage farms, where grain is produced in large quantity, the barn is an important part of the buildings of the farm; but on mountain and upland farms, where pasturage is almost exclusively practised, the barn becomes less necessary. In the construction of barns a great change has taken place since the introduction of the thrashing machine. They were formerly constructed of dimensions capable of holding the greater part of the produce of the farm; but experience has shown that grain is much more perfectly preserved in the stackyard, than when placed in barns.

When the flail is used in the operation of thrashing, the barn usually consists of a plain oblong building, without any internal divisions, and of a size proportionate to that of the farm. It is made to hold one stack of corn at a time, and besides the space occupied by the corn, room must be left for the thrashing-floor on which the grain is placed for the action of the flail. An essential circumstance in the arrangement of the barn, in this case, is the formation of the thrashing-floor of suitable materials and in a convenient situation. It is for the most part placed in the centre of the building, but it may be laid down in any other part that may appear more convenient. In the construction of these floors various sorts of materials are employed, such as compositions of earthy matters, stones, bricks, and wood. The last substance, when properly laid and put together, is probably the best and most secure from damp. When made of wood, they are sometimes arranged so as to be moveable at pleasure. The dimensions may be from twelve to fourteen by eighteen or twenty feet. The materials should be well seasoned previously to their being put together, in order to guard against shrinking afterwards; and it is to be observed that the platform, thus made, is to be slightly raised above the other parts of the floor.

When the thrashing machine is employed, the barn is conveniently divided into a number of apartments, to facilitate the work in the operation of thrashing, and to enable the unthrashed corn to be kept separately from the grain and straw. The barn for thrashing consists of two apartments, the one above the other. In the upper apartment is placed the unthrashed corn, as it is brought from the stack; and in the event of the farmery being placed in an inclined situation, advantage may be taken of this circumstance by placing the entrance to this apartment in the same plane with the surface of the ground outside, which secures ready ingress and egress with the corn. The thrashing machine is placed at one end of this apartment, and it extends to that below. In this apartment also is placed the table on which the sheaves are spread out, and the feeding-board at which the man stands who supplies the corn to the machine. The lower apartment is called the dressing barn, as the grain is received in it from the thrashing machine, and is there winnowed and prepared for use.

The remaining apartment connected with the barn is that in which the straw is received as it falls from the machine, and when it is stored up for use. This is termed the straw barn. It should be of sufficient size to contain the produce of one stack, at least; and it is desirable that it should be even larger, so that straw may be preserved dry, after being thrashed in severe weather.

In the construction of the barn it is important that arrangements be made for ventilation and the admission of light. These objects are effected by glazed windows consisting of two sashes, so that they may be moved up and down, or by means of what are termed luffer-board windows, or such as are formed of small slips of wood instead of glass; and when the spaces between these bars, in the latter case, are not sufficiently small to prevent the smaller birds from getting into the barn, the whole is to be protected outside by a trellis-work of wire, the meshes being of a size to prevent even the smallest birds from passing through them.

The floors of the barn should be formed of wood, and so arranged as to prevent the depredations of vermin. These frequently make passages into the space below the boards along the edges of the flooring, between it and the walls; but this may be prevented by skirtings of thin sheet-iron placed round the apartments, and so formed as to overlap the floor an inch or more. The joining of the skirting with the wall is to be well filled up with mortar, and the lower part is to fit accurately to the floor.

The position of the barn, relatively to the other buildings of the farmyard, depends on the position of the stables and cattle houses. Being the part whence the fodder and litter are carried, it should be placed so to afford the readiest access to other buildings. It is usually placed as near the centre of the range as the general arrangement of the farmery will allow. When the thrashing machine is driven by steam or horse power, the barn may be placed in the situation found most convenient; but when it is to be driven by water, local circumstances must often determine its position. In general, as the buildings of the farmery form a shelter to the cattle-yard, and as the barn is the highest of these buildings, it should be placed on that side from which the coldest winds blow; and this is also favourable for its proximity to the stackyard, which ought to be in the most exposed situation, for drying the corn when it is newly stacked. In this situation it has also the best effect in an architectural point of view.

The fixtures and implements of the barn besides the thrashing machine, are the winnowing machine and riddles of different kinds, some of which have close bottoms for the purpose of filling the grain into sacks, or removing it from one place to another. A set of beam and scales with weights, or a weighing machine, will be found to be convenient articles of furniture in the barn. Other necessary implements are a broad wooden or sheet-iron shovel for shovelling the corn into heaps, and a load-barrow for carrying filled sacks.

2. *The Dairy.*

On farms where cows are kept, the dairy is one of the most important of farm offices, and yet it is seldom properly constructed. The apartments for carrying on the operations of the dairy usually form a part of the farm-house itself, perhaps for the purpose of greater security and convenience, but a better arrangement is, that it should be detached altogether from the other buildings. The desiderata in the construction of the dairy are, equality of temperature during every season of the year, and frequent renewal of the air, so as to have it perfectly fresh and sweet. Equality of temperature is easiest obtained when the dairy is underground; but in this case the ventilation is insufficient to supply the other desideratum. The situation for the dairy should be shaded by trees, to prevent the great increase of temperature which is produced by the rays of the sun.

The dairy should consist of several apartments, in order to admit of the operations of churning, cheese-making, and rinsing and scalding vessels to be carried on, without interfering with the milk in the vessels, or raising the temperature of the milk-room beyond the required degree. That it may fulfil the several purposes for which it is intended, it must contain a milk-room, work-room, and store-room.

The milk-room is intended to contain the milk previous to obtaining from it the cheese or cream. It should have its windows to the north, and be so formed as to preserve a cool and equal temperature. The windows should be formed of gauze cloth, which may exclude flies, but admit the air, and protected from mice and accidents by iron bars and a grating of wire. This apartment should be kept cool in summer, but in winter heated by a stove or otherwise, so as to maintain a temperature of from 50° to 55°.

The work-room is that in which the different manual operations are performed. It is to be fitted up with a boiler to boil water and heat milk; and it should be of sufficient size to allow of performing the operations of churning, cheese-making, and washing the dairy vessels, and the like.

The store-room is intended merely to keep the cheeses when made. It may be placed wherever convenient, and should have a certain degree of warmth, without being too much heated or lighted.*

But the apartments enumerated are only necessary when the number of cows kept is large, and the operations of the dairy extensive. On a smaller scale, as that of most farms, the only essential apartment is the milk-room, and this is indispensable in every case. The operations may be performed in some other apartment; for it is to be observed that the milk-room should be resorted to as little as possible, and in no case is churning or washing to be carried on in it.

The fixtures of the dairy are shelves placed in various positions, on which the different vessels and utensils are placed, and the number and arrangement of these are necessarily determined by the size of the establishment. The utensils are,—1. Milking-pails, which may be formed of wood; 2. Sieves of hair or wire gauze, for the purpose of passing the milk through and retaining the impurities; 3. Vessels for holding the milk until the cream rises upon the surface, and a vessel for containing the cream ; 4. Flat dishes of willow, ivory, or horn, for the purpose of skimming the cream from the surface of the milk ; 5. A churn ; 6. A wooden vat or tub, in which the milk is placed when the curd is coagulated ; 7. A cheese knife, for the purpose of cutting or breaking the coagulated curd, that the whey may be separated ; 8. A vessel perforated with holes, in which the curd may be placed, that it may be broken and the serous matter further separated ; 9. Cheese vats ; 10. A cheese press.

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* Elements of Practical Agriculture.

The utensils more especially employed for the making of butter are the dishes for holding the milk until the cream separates, the skimming dishes for removing the cream, a vessel for holding the cream, and the churn.

The dishes for containing the milk are made of various substances, as marble, slate, tinned iron, earthen ware, and wood. Lead is sometimes employed, but improperly, as it may be acted upon by the acid of the milk ; and so likewise may iron, if not defended by a coating of some substance. The milk may either be contained in one large vessel or trough with a stop-cock at the bottom, so that the milk may be withdrawn, leaving the cream in the trough, or it may be put into separate shallow vessels. These last have been recently made of cast iron, smoothed within and coated with tin ; and more recently zinc has been employed. Either of these substances is superior to the common material, wood. They are more easily kept clean, and sooner cooled, which contributes to the more ready separation of the cream.

Churns are of different constructions ; the most common is that of a plunge-churn, moved by the hand. The form of this domestic instrument is every where known. It consists of a cylindrical vessel of wood, placed upright ; and the agitation is given to the milk within by a perforated board, which nearly fits the cylinder, and to which is attached a long handle. This being moved up and down, agitates the milk until the butter is separated. But sometimes, in place of a cylinder standing upright, there is employed a small barrel placed horizontally, and sometimes a square box. Through the box or barrel there passes a wooden axle, to which arms are attached, and motion being given by a handle, the milk is agitated and the butter separated.*

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* Elements of Practical Agriculture, pp. 540, 541.

3. *Cart-shed and Implement-house.*

The injurious effects of the exposure to the weather on structures of wood are well known, and they have suggested the propriety of placing the carts and other implements of the farm in situations where they would be free from exposure. The carts and larger implements are usually placed in sheds open in front, but defended on all other sides from the prevailing winds. The circumstances to be attended to in the construction of them are to place the open side in that direction which is most sheltered, and to preserve the implements in it from rain through the roof. It is not, however, necessary that the whole of the apartment should be devoted to that purpose, and it has accordingly been found an economical arrangement to have the granary or some other store-room above the cart-shed.

Connected with the cart-shed there may be some apartment for holding the smaller implements, which is to be secured by a door and lock. One part of it may be devoted to the carpenter's tools, which it is necessary should be on a farm, as saws, planes, hatchets, augers, and the like.

Among the buildings used as repositories, the granary may be mentioned; but, except on the larger class of farms, a separate building will not be necessary for holding grain, as a considerable quantity may be kept in some of the divisions of the barn. The most convenient situation for the granary, however, is above the cart-shed. In barns with thrashing machines, it is sometimes formed immediately above the floor on which the machine works, which admits of the corn being immediately raised to it from the ground floor, either by the thrashing machine itself, or by a windlass easily worked by one man. In this case, as well as in every other in which the granary is placed over another building, it is always convenient to have a windlass to it; either immediately over a trap-door in the floor, or over a door in the outside wall.

Store-rooms for potatoes and other roots may be enumerated among the repositories for farm produce. A small apartment will be sufficient for this purpose, for it is found that they are better preserved in other situations, yet it is necessary to have a few weeks' supply always at hand, to prevent recourse being had to the fields during stormy weather.

II.—BUILDINGS FOR THE ACCOMMODATION OF LIVE STOCK.

1. *The Stable.*

The horse is an animal in a highly artificial state, and requires to be treated with a degree of care beyond that bestowed on any other quadruped. Cleanliness and ventilation are essential requisites in stable management, and such an arrangement is to be adopted as will best secure them.

The stables must be of a size sufficient for the number of horses employed in working the farm. They ought to be sixteen feet wide in the inside, and the walls may be eight feet high, there being no ceiling, but their entire space open to the roof. The width for each stall should not be less than five feet and a half, and these are to be separated from each other by partitions. These latter sometimes only separate the horses into pairs, those which work together in harness being placed together in the stable, and in this way they are made to occupy less room; but it has been observed, that when horses are crowded together, they do not lie down near so frequently as when they have ample space. When it is considered how much the health of all quadrupeds depends on their reposing a certain portion of the twenty-four hours in a horizontal position, and more especially when we reflect, that the horse is particularly liable to have swelled legs and heels, we cannot avoid arriving at the conclusion, that horses ought to have separate stalls, with divisions so high as to prevent them from seeing each other, and that these should be of sufficient width to admit of the animals rising and lying down without inconvenience.

The floor of the stable is formed of pavement of small stones, carefully placed by the hand in such a manner, that they will not be displaced by the feet of the animals. That part on which the horses stand should be level, or, if at all inclined, the inclination should be very slight; for, when raised towards the horse's head it is found to put the back sinews on the stretch, and thus to fatigue the animal when he ought to be at rest. The urine may be carried off by a small covered drain under each apartment, over which a grating is placed, and these all running into a main drain, convey the urine into a receptacle formed to receive it. The gratings are to fit into the openings above the drains, so as to be quite close and level with the adjoining floor, and they are placed in such a manner, that they can be removed for the purpose of cleaning out the drain. The great advantage of this arrangement is, that the evaporation of urine in the stable is, in a great measure, prevented by it; and not only its atmosphere rendered much more healthy, but the ammonia of the urine is conveyed to the tank of liquid manure, of which it forms one of the most valuable portions. To get rid of this ammonia in the stable, all droppings from the horse should be removed immediately, if practicable; and, at all events, the litter which has been stained by the dung and urine ought to be removed to the dung-pit, at least twice a day when the horse is standing in the stable, and regularly in the morning when he is in the stable only during the night. It is the practice with some farmers to clean out their stable only once or twice a week; but the exhalations produced from such an accumulation of fermenting matter cause many diseases, especially of the eyes and respiratory organs; and the floor, being unequally covered, is rendered uneven for the horse to stand on, so that he is strained and fatigued instead of being rested.

Although lofts over stables are not to be recommended, circumstances may justify the arrangement; but then the lofts must be high, and ceiled below, to prevent the effluvia of the stables from penetrating through them, and injuring the hay or other matters that may be placed upon them. As stables with hay lofts are commonly constructed, the hay is much injured, and, being more confined, the animals frequently suffer from defective ventilation. The best method of ventilating the stables in winter is by trunks or tubes of boards, about a foot square, forming openings under the eaves, or carried up through the ceiling, where there is one, so as to pass through the roof, their tops being covered in such a manner, that the rain shall be excluded without impeding the ascent of the heated air. The inside openings of these tubes are to have small sliding shutters to regulate the ventilation. In summer the same object is effected by the moveable sashes of the windows.

An important object in the construction of stables is to secure the admission of light during the day. This arrangement is frequently neglected, but more correct ideas regarding the management of domestic animals abundantly show the necessity of it. The stable should have one or more windows according to the size, both for ventilation and light; and each window should consist of two sashes, moving up and down by pulleys, or sliding past each other in grooves. The windows are to be glazed, and protected by a luffer-boarding, the laths being placed in a horizontal position. The annexed figure represents a window consisting of two sashes which slide past each other, and they are formed without horizontal bars, in the manner of hot-house sashes. The intention of this mode of glazing is to avoid collecting the moisture and dust, which otherwise are always found on the cross-bars of stable and out-house windows. The construction of the luffer-blinds is shown on the lower half of the window.

Fig. 21.

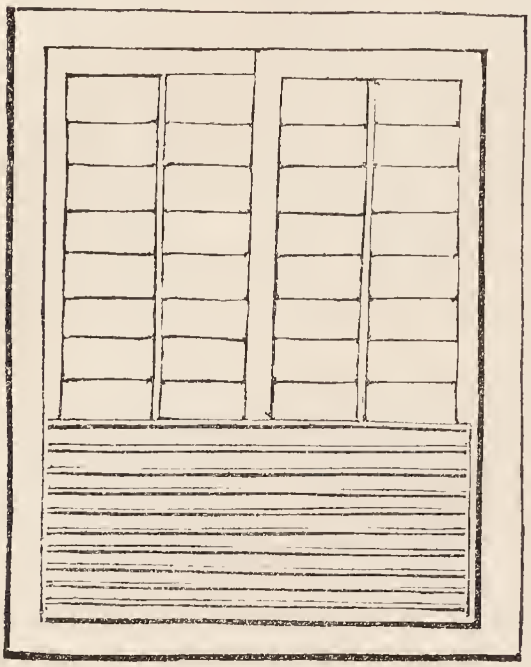
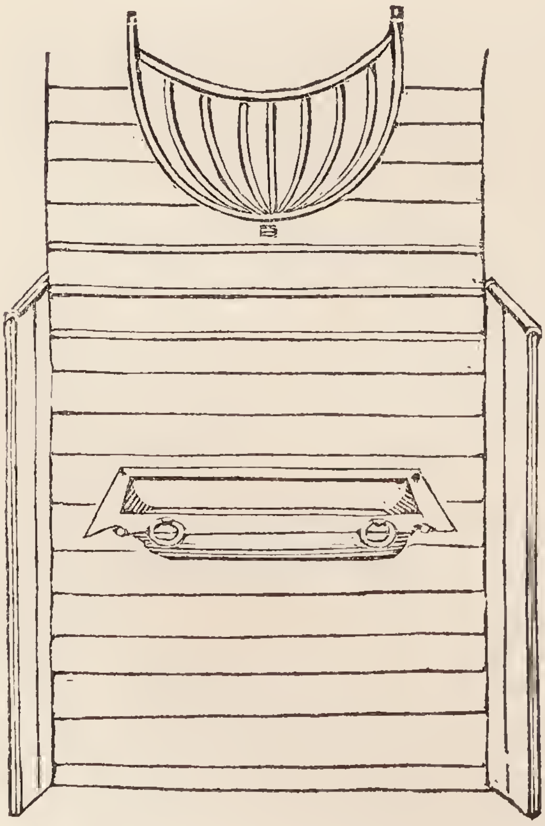


Fig. 22.



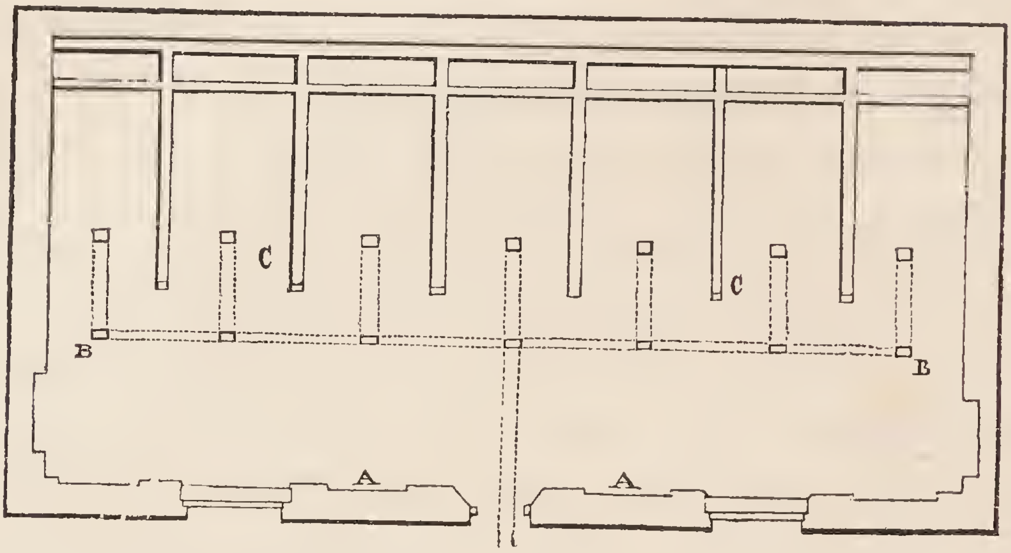
The rack and manger have long been regarded as essential structures in the fitting up of stables, and are still very generally employed; but when the better and more economical plan of cutting the fodder is adopted, the rack will become unnecessary. Upright racks are to be preferred to those inclining forwards, as, in the latter case, the horses are often much annoyed by the small seeds falling into their eyes and ears in drawing out the hay. Racks and mangers are very frequently constructed of cast iron, and these are found much more durable and economical than those formed of wood, without any inconvenience being experienced from them. *Fig.* 22 represents a cast iron rack, two feet four inches long, one foot three inches wide at the top, and one foot four inches high. The bars are an inch and a half by five-eighths of an inch in thickness, and two inches and a half apart, the whole weighing about thirty pounds. Below it is seen a cast iron manger, three feet long, one foot three inches wide at the top, and eight inches deep. It weighs about seventy pounds.

A space of several feet is necessary for a passage behind the horses, to admit of their passing in and out, to and from their stalls, to afford room to the men employed in working with the horses to perform any necessary operation connected with the care and repair of their harness, and to admit of the harness being hung up against the wall behind. Under each window may be a recess for holding an oil-can, or vessel with tar; and, if provided with a door, it may be used for holding the combs and brushes which are employed in cleaning the horses. Every part of the harness in daily use should be placed behind the horse to whom it belongs, in order that no time may be lost in taking it off and putting it on; and that which is used only occasionally is to be kept in a separate lock-up apartment. There should be one or more lanterns suspended by cords and pulleys over the passage, for putting lighted candles in while feeding and cleaning the horses during the winter. The loft being condemned in farm stables, a place must be provided for holding the food and litter; the most convenient will be one or two divisions opposite the door, into which the food, whether green clover or tares in summer, or hay or roots in winter, can be readily carried from without, and easily distributed within. Being near the door, the food will be better ventilated than it could be in any other part of the stable, and it will occupy the least valuable part with reference to the horses; it being well known that the horse that stands opposite to the door is more liable to take cold than any other. The corn-bin or chest may also be kept in one of these divisions, and it ought to be large enough to have separate apartments for corn and beans, and for cut straw or hay, or bruised furze, to mix with the corn or pulse. The doorways should be four feet wide and seven feet high; and the door must not have any projecting latches or handles, because they are apt to hurt the horse, or become entangled with the harness in passing out and in.

Fig. 23 represents the ground plan of a stable with high racks, mangers, and partitioned stalls, constructed and arranged in the manner described. It is made to contain seven horses, but the principles on which it is constructed are applicable to stables of any extent.

In the front walls there are recesses, A A, six inches or more deep, according to the kind of wall, for hanging harness in the upper part

Fig. 23.



and for pails and other articles used in the stables to stand in below. The dotted lines from B to B represent the main gutter drain, and the short dotted lines from it, C C, the branch drains into the different stalls; the dotted lines, passing under the stable door, indicate a drain communicating with the liquid manure tank.

2. *The Cattle Sheds.*

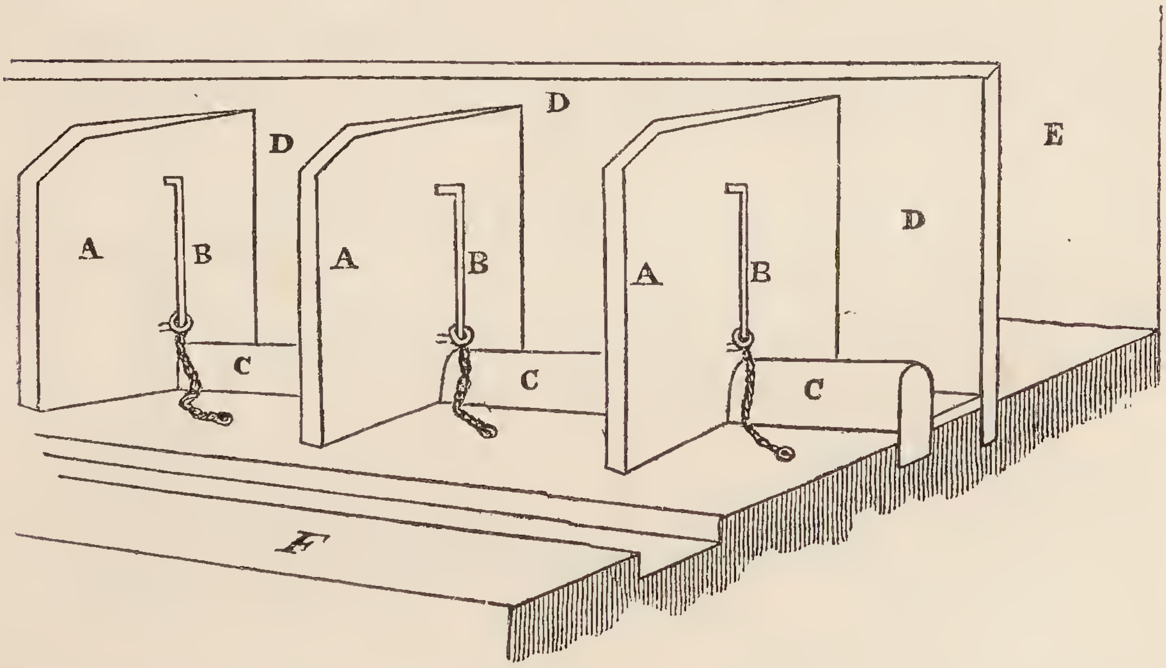
Cattle sheds are used either for lodging milch cows or young cattle, or for stall feeding for the butcher. The principal requisites in buildings of this decription, are to be capable of being properly ventilated, to be constructed so as to require the least possible labour in feeding the cattle and cleaning away the dung, and to have the stalls so formed as to keep the animals dry and clean, with sufficient drains to carry away, and reservoirs to collect the urine and dung.

The common method of arrangement in these houses is to place a long beam of wood about five feet high and two feet from the wall at the heads of the animals; and to this beam the posts are fastened to which the cattle are attached. The usual distance of these posts is about four feet. A moveable ring is placed round each post, from which a chain is extended round the neck of the cattle, and they feed from a low manger or trough, formed merely of a raised edge of stone or wood, between which and the wall the food is placed.

A more perfect arrangement is now adopted in modern structures, and it is deserving of general introduction. This consists in placing the heads of the animals at such a distance from the wall as to leave a narrow pathway in front by which the food can be more easily placed before the cattle, and placing each animal in a separate stall, the stalls being divided by low partitions just of sufficient size to prevent them from interfering with each other. A moveable ring and chain are also here used for attaching the animals, the ring being in this case moving on a vertical rod instead of the wooden post. This arrangement is represented in *Fig*. 24.

In the figure, A A A are the partitions between the animals; B B B, the upright iron rods, to which are fixed the rings and chains by means of which the cattle are tied; C C C represent the raised edges, or curb stone, of the manger in front; and D D D the partition separating the manger from the pathway by which the food is conveyed to the stalls. E is the pathway in front, and F that behind the animals.

Fig. 24.

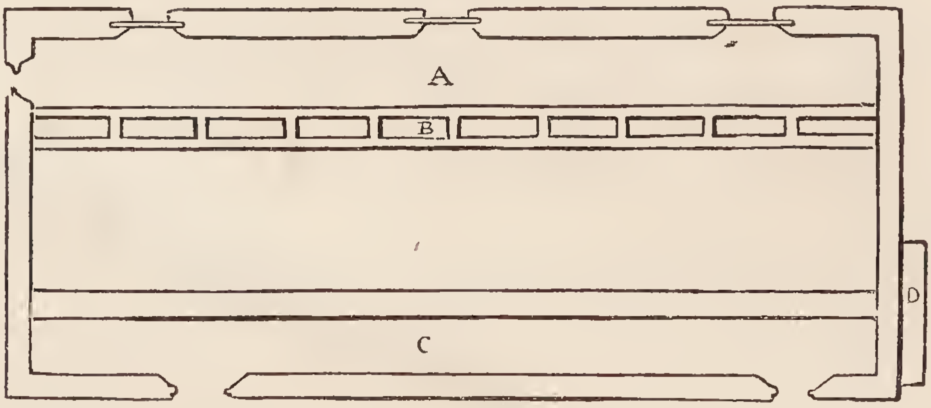


In the internal arrangement of cattle sheds for cows or oxen, the animals may be made to stand either across or along the building. When ranged lengthwise, the width of the house should be, at least, sixteen feet, and the space allowed for each of the animals of the larger kind should be five feet. The distance from the manger to the wall, being the passage for carrying along the food, may be four feet, to admit the attendant to supply the animals with their food with facility. A distinguishing feature in the arrangement of houses in which cattle are tied up is the open gutter behind, which is rendered necessary on account of the comparatively fluid nature of the dung of the animals. The space between the manger and gutter is regulated by the size of the animals which are to occupy the stalls. The gutter is generally made a foot broad, and three or four inches deep; and it is usually made perpendicular in the sides. Whatever may be the shape and dimensions of the gutter, it is of importance to have the hoe or scraper which is used in cleaning out the manure of a corresponding size and shape.

The organization of cattle being less delicate than that of the horse, they are not so liable to suffer from vicissitudes of temperature as that animal, and the same precautions for maintaining an uniform temperature in their houses are not necessary. Complete ventilation is, however, essential, and, to secure this object, milch cows, as well as young cattle, are frequently placed in open sheds, care being taken that the open side of the shed is not exposed to the prevailing winds, and is otherwise sheltered as much as possible.

The most convenient arrangement, especially in the case of the larger-sized aninals, is probably that in which they stand lengthwise in the house, as represented in *Fig.* 25. A is the space in front of the mangers B, for carrying along the food. C is the passage behind them in which the attendant stands in cleaning them out, and from which he supplies them with litter. The gutter communicates with the reservoir D, from which the dung and urine are conveyed as occasion may require.

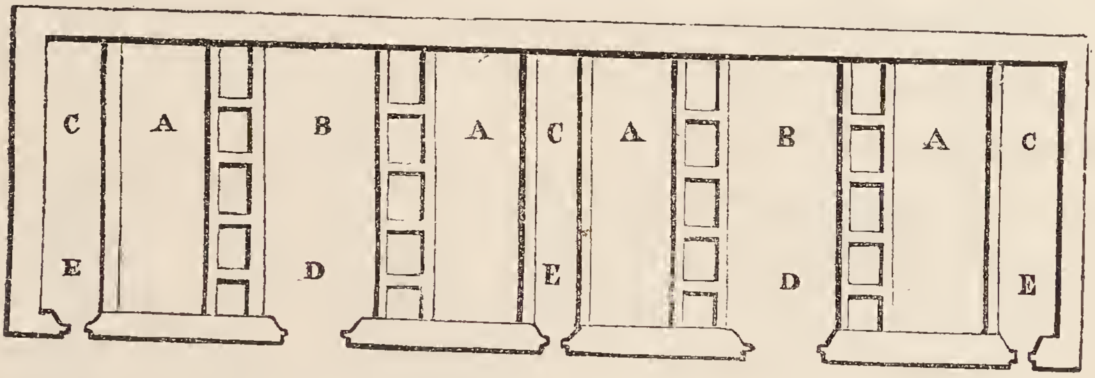
Fig. 25.



This arrangement is simple and efficient. The animals are supplied with food, and cleaned out with facility; but this is not the only plan of arrangement by which these objects may be effected.

A cow-house, or cattle shed, in which the animals stand across the building, will afford the same accommodation as that in which they stand with their heads against the side-wall, at less expense of walling and roofing, for the passages before and behind serve for the accommodation of two sets of cattle. The following figure represents the ground plan of a cow-house in which this plan of arrangement is adopted.

Fig. 26.



The feeding shed here delineated is sixty feet in length, by eighteen in width, and is capable of containing twenty cattle. A A A A represent the spaces in which the animals are to stand, five being allotted to each ; B B, passages for feeding, along which the food is carried, and they are made sufficiently wide to admit of the loads being emptied in them from the carts ; D D are the doors to these passages ; C C C are spaces, four feet in breadth, behind the animals, for the purpose of cleaning them out, and of admitting them to pass each other in going to and from their stalls ; and E E E are the doors to these, by which the cattle pass in and out.

The calf-houses are to be placed convenient to the cow-houses, to lessen the labour of carrying the milk to them ; but they should not be so near as to permit the cow to see or even hear her calf. In the construction of these apartments the chief requisites are to secure cleanliness and a proper degree of heat, and to guard against dampness, which would be fatal to the young animals. To effect the latter purpose, the floor should be raised some distance from the ground, and formed of laths or bricks, placed in such a manner as to allow any liquid matter to pass through ; and this artificial floor is to be raised so high above the surrounding surface, as to admit of the intervening space being cleaned out occasionally, otherwise, it would become a receptacle of filth, producing the most offensive exhalations. The litter is thus kept dry under the calves, but it must not be allowed to accumulate for a length of time, for the mass thus formed would prevent the moisture from getting through.

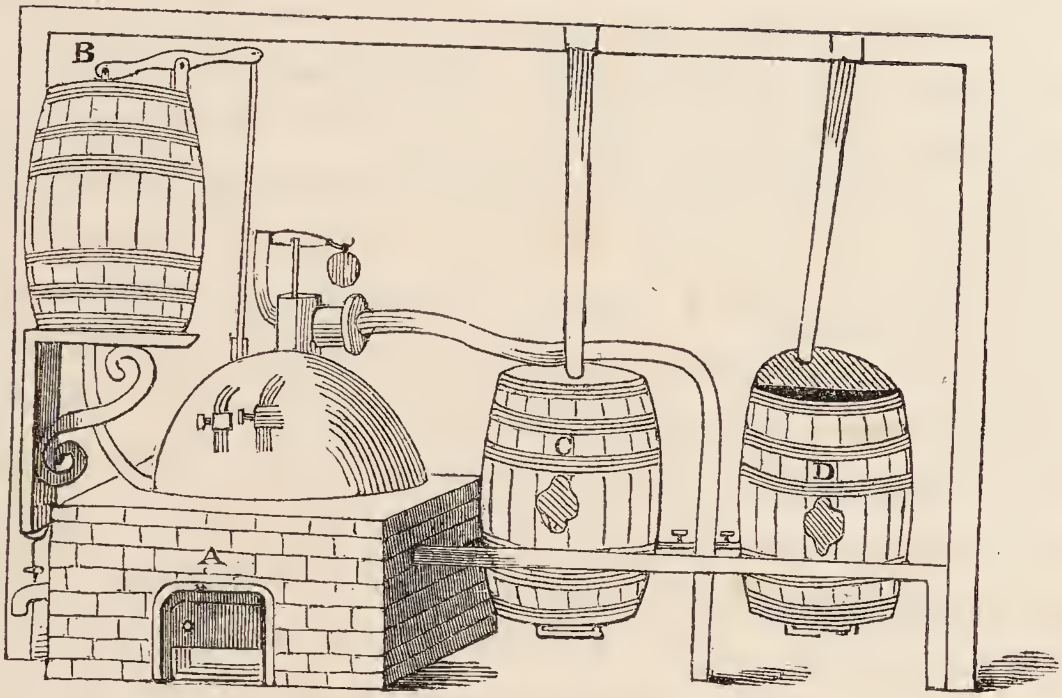
The interior arrangements of calf-houses are sometimes similar to those described, and they are, in fact, cow-houses in miniature. A more simple and equally convenient arrangement consists in placing the calves in separate divisions, each having a manger or crib for holding a small quantity of hay, or young grass, according to the season. The partition between the calves should be so high as to prevent their reaching over to one another; for otherwise, they suck each other's ears, and often suffer from lumps of matted hair being thus conveyed to the stomach.

The feeding cattle may have houses of the same construction as those described; but they may also be fed in yards with sheds attached to them, to which they can retire during the night or in stormy weather. It has been found, that many varieties of cattle, and particularly those reared in mountainous districts, which are naturally small and active, do not fatten so well when tied up in stalls as when left loose in a limited space, with a well-littered house or shed to take shelter in at pleasure. But besides the more hardy varieties of cattle being reared and fattened in this manner, the practice has lately been adopted with the finer and more improved breeds, and the result has been such as to warrant the conclusion, that the practice is equally suited to them. In each yard there should be a rack for holding straw or hay, and a trough for holding the turnips and other green food. When turnips are used, the cattle require no water, but when fed chiefly on dry food, arrangements must be made for the conveyance of water into the yards.

Connected with the cattle sheds and feeding yards, there may be an apartment for boiling or steaming food, in which a steaming apparatus is placed. Any kind of wooden box or barrel will answer for this purpose, so formed as to be readily filled and emptied. The steam is to be conveyed in a pipe to the lower part of the vessel, which ought to have a sliding board at the bottom to allow the contents to be discharged when ready. The vessel may be filled with water, though this is not necessary in the case of succulent roots, as the potato and turnip, because the steam is quickly condensed. But when corn is to be boiled, it should be covered with water to effect the condensation of the steam.

An apparatus of this construction is represented in *Fig*. 27. It consists of a furnace and cast-iron boiler, A, furnished with a safety valve to render it secure from danger even in the hands of the most inexperienced person. This boiler may be made to supply warm water for other purposes in the farmery, the water being drawn off by a cock in the lower part of it. It is supplied with water from a cistern, B, placed at the height of five or six feet above it. When filled the cistern requires no further attention, as the boiler regulates its supply of water by means of a float inside, attached to the valve in the cistern. Two casks, C and D, are intended to hold the potatoes, turnips, or other matters to be steamed. The steam is conducted to these from the boiler by a pipe branching off to each by stopcocks. As many casks as may be necessary for the supply of food may be attached in the same way. These, it has been said, are furnished with sliding hatches in the bottom for taking out the food when ready, and are raised as far from the ground as will admit a barrow or trough to be introduced under them, to receive the contents when they are ready to be withdrawn.*

Fig. 27.



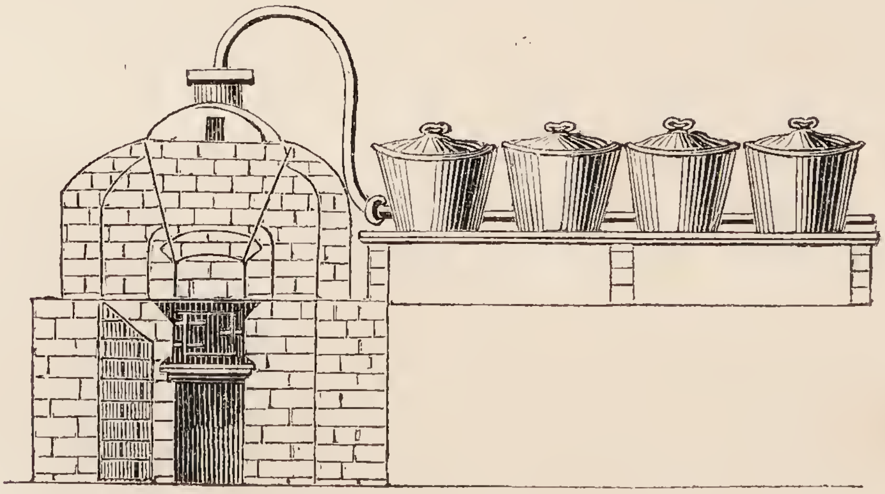
For boiling grain, the cask for holding it differs from those used in steaming roots, only, by not having a hatch in the bottom, as the hatch could not be easily made tight, which is necessary in this case,

* Prize Essays and Transactions of the Highland Society. New Series, vol. i.

as water must be mixed with the grain in the same quantity, or nearly, as if it were to be boiled in a boiler in the common way. It may be added, that the hatch not being tight in boiling potatoes is an advantage, and even necessary for allowing the condensed steam to run out, and also all the earthy matters from the skins of the potatoes. In the figure, one of the casks is represented with the lid pressed down by means of the vertical bar, which is employed for this purpose during the operation of boiling or steaming. In the other cask, the lid is represented as opened, with the vertical bar removed to one side.

A steaming apparatus of an improved construction is represented in *Fig.* 28. Like that already described, it consists of a metal boiler with safety valve and cocks, from which proceeds the pipe which supplies the buckets with steam by stopcocks branching off to each. The buckets in this case are entirely composed of cast metal, made to hold a determinate quantity, as a bushel or two bushels, and slide with facility off their stand when ready to be emptied and refilled. Barrels or other capacious vessels may likewise be attached, to which additional pipes convey the steam; warm water may constantly be had from the boiler, and the superfluous steam may be usefully applied for heating and other purposes of domestic economy.

Fig. 28.



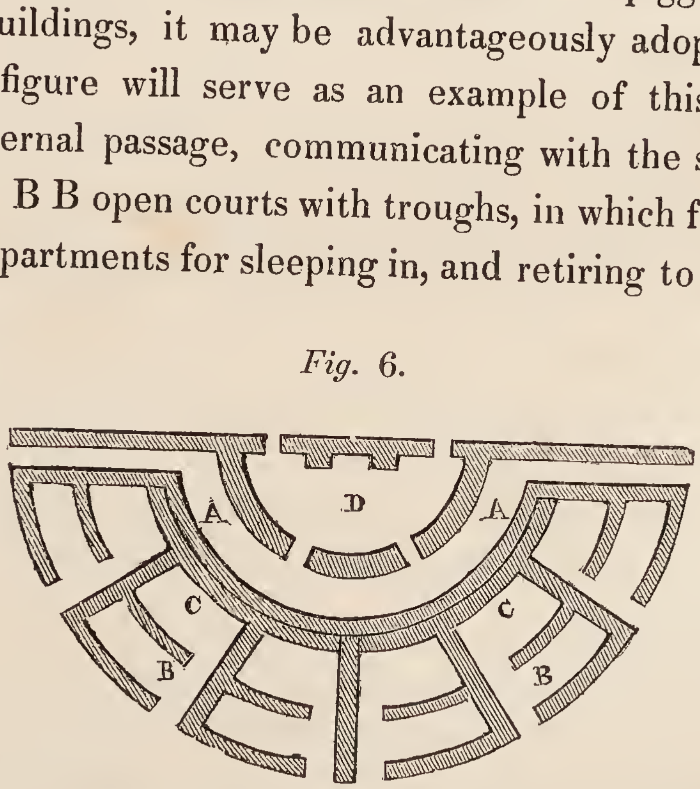
3. *The Piggery.*

On every farm there should be sufficient accommodation for the swine. The hog is an inhabitant of all climates, and is almost omnivorous; but he is known to thrive much better when confined in a sty in which an equable temperature is preserved, than when exposed to sudden alternations of heat and cold. In most cases, the Irish farmer considers he has made sufficient provision for the accommodation of his stock of swine, when he has provided a shed for them to retire to during the night, and allowing them to roam about during the day, doing inconceivable injury to the pastures, and other grounds to which they have access.

The construction of the piggery is extremely simple, each sty consisting of a covered lodging, and a small open court; the latter for feeding, and the former for sleeping in; but the feeding troughs may also be placed in the covered part of the structure, especially for fattening pigs. The floor of the piggery is constructed so as to have a slight inclination, to carry away the moisture; and it is to be formed of flags or pavement, carefully laid, for otherwise the animals will destroy it, and so tear it up as even to injure the walls by making excavations under them. Abundance of litter is at all times necessary for the comfort of swine; indeed, under a good roof and well supplied with dry litter, they will keep themselves warm and comfortable, almost any where, and in any season.

In the arrangement of the piggery, the several apartments may be disposed in the rectangular or circular form, as local circumstances may render convenient; but the circular form of arrangement is conceived to be the preferable one, and when the piggery is detached from other buildings, it may be advantageously adopted. The accompanying figure will serve as an example of this arrangement. A A is an internal passage, communicating with the several parts of the building; B B open courts with troughs, in which food is supplied; C C covered apartments for sleeping in, and retiring to during stormy weather. In the open space D, arrangements may be made for storing a supply of food, and a boiling or steaming apparatus on a

Fig. 6.



small scale might be conveniently placed in it. This arrangement will be somewhat more expensive than when the rectangular form is adopted, but it presents the great advantage of enabling the animals to be supplied with food with very little trouble. The principle of construction may be adopted with equal facility in a piggery for a small number of swine, as well as for those on a more extensive scale.

4. *The Poultry Houses.*

The remaining buildings of the farm appropriated to the use of live stock are the poultry houses. A house of this description is still less frequently to be met with in this country than even a piggery. Where a few poultry only are kept, it may not be necessary to erect a structure for their sole use, as they generally take shelter themselves in some of the sheds, and pick up the greater portion of their food about the barn and stable; but when thus allowed to wander about the houses, they sometimes commit great destruction, both in scraping up any newly-turned-over piece of ground, and in the corn fields during the harvest, to which they frequently find the way, and thus become a source of much annoyance. In every case, indeed, in which poultry are kept, arrangements should be made for confining them at such periods as may be required.

Poultry houses require to be of no particular form or size, because the animals themselves being small, there is no necessity for accommodating the shape of the house to their particular figure. Both terrestrial and aquatic poultry agree in requiring a dry and rather warm lodging; and they differ, in the web-footed birds all roosting upon a flat surface, while gallinaceous fowls roost at some height from the ground, on roundish horizontal rods not perfectly smooth. All fowls, when in a state of incubation, require repose, to which darkness is favourable as well as solitude. They also are exceedingly active while growing, and in an artificial state require space for exercise, which is conducive to health.

Poultry may be classed into three divisions, so far as regards providing them with suitable accommodation; namely, the aquatic, which must be lodged on the ground floor; the common cock and hen, which prefer the floor above; and the turkey, guinea-fowl, and peafowl, which roost in lofty open sheds, or on trees. On a small scale, therefore, all the different kinds may be lodged in the same house: ducks and geese, with the other kinds, while rearing, on the ground floor; common fowls, when full grown, on the middle floor; and the turkey and others above. For the gallinaceous tribe, it must contain abundance of sand and small pebbles; and for the aquatic fowls, a pond. It will be necessary to surround the yard with a railing, placed on the wall enclosing it, to keep in the common fowls.

III.—BUILDINGS AND ENCLOSURES FOR THE COLLECTION OF MANURES.

The importance of constant and unremitting attention to the collection of manure has already been pointed out in a preceding part of these pages. The sources from which the stock of this article is chiefly procured, are the stables and feeding houses of the farmery; and the supply thus obtained is conveyed to a yard or other place prepared for its reception, in which it is preserved until required for use. A large portion of manure is also obtained from the fold-yards, and sometimes these serve as receptacles for the entire stock of manure produced upon the farm, it being deposited in them as it is conveyed from the stables and feeding houses.

The dung-yard should be placed in a central situation, with regard to the cattle houses and stables, for receiving the dung produced in them as it is daily wheeled out. The common situation is the centre of the farmery, when it is enclosed by a wall, against which, in large farms, there are frequently open low sheds for cattle, and apartments for the accommodation of swine. Both these kinds of animals, as well as poultry, are allowed the run of the yard over the dung, to which they do good rather than harm; the pigs and poultry, by picking out grains and seeds, which would otherwise be lost, or spring up as weeds when the manure is spread upon the land; and the cattle, by treading the straw into the moister part of the manure, and thus preparing it for being carted out and placed in a heap to undergo the process of fermentation.

The surface of the dung-yard is to be so made as to slope towards the centre, or towards some point which is lower than any other part of the yard; and under this point there are to be two capacious tanks for containing the liquid manure, with which all the drains from the stables and cattle sheds are to communicate. The tanks should communicate with each other, and the one may be used for containing that which is recently collected, while that in the other is fermenting previously to its being used as manure. The tanks may be emptied by means of a pump, which may either remain permanently placed above them, or be removed at pleasure.

On the smaller class of farms a dung-pit is frequently substituted for the dung-yard, into which the dung produced in the surrounding houses is thrown. This pit may be made sufficiently deep to contain the urine among the dung, but it is better that any superfluous urine should be conveyed by means of drains to suitable receptacles. The urine among the dung will be preserved from evaporation in the heap by covering it lightly with dry loose straw. A certain portion of moisture is found to be essential in the dung-yard, but all excess is to be carefully removed in the manner described.

IV.—BUILDINGS USED AS HUMAN HABITATIONS.

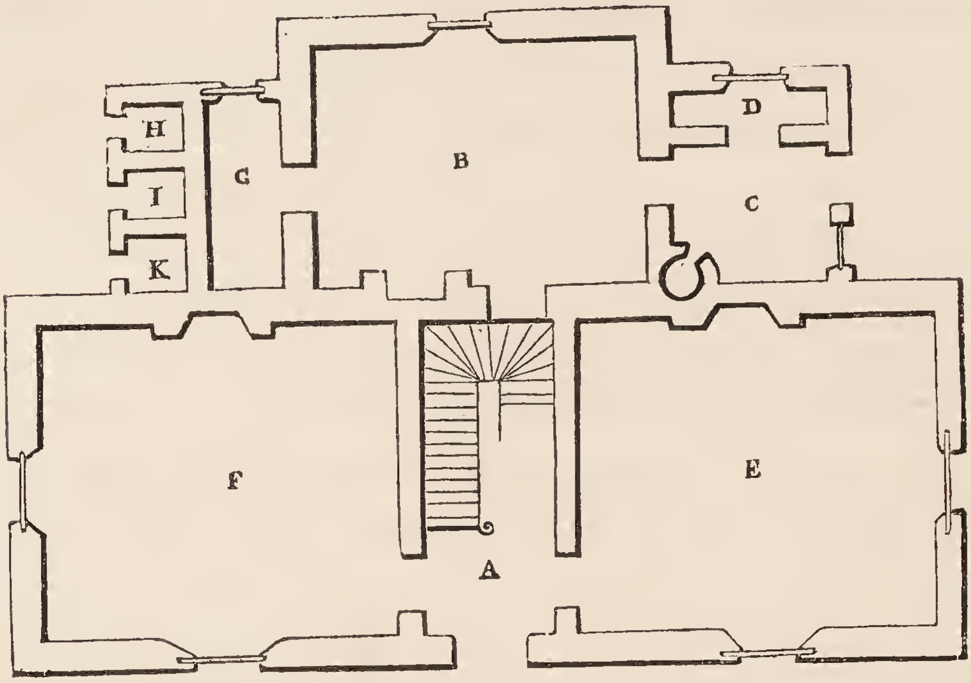
The edifices of this class, which are necessary upon the farm, are those intended as residences for the farmer himself, and also for one or more of the persons engaged in the cultivation of it. The character and extent of these are regulated altogether by the extent of the farm, and the taste of its occupier. In many cases the occupier of the soil is little removed in his general condition from the labourer, and in these the accommodations necessary will be of the simplest kind; but as the following remarks are intended to apply to farmers considerably removed in their social condition from the day labourer, and occupying an extent of land calculated to afford them not only the necessaries but also a few of the luxuries of life, it is better that reference should be made in this place to farm-houses of the better class.

The house for the accommodation of the farmer does not differ, in many essential particulars, from that of the residence of any other person moving in a similar sphere. The size, and extent of accommodation, are regulated by the circumstances which have been already mentioned; but even when of the smallest size and simplest construction, the farmer's house should not be deficient in any thing essentially requisite for the health, comfort, and convenience of even the most luxurious of mankind. With regard to household accommodation, as in other matters, all the necessaries and comforts of life may be contained within small bounds, and are within the reach of a far greater portion of mankind than is generally imagined. The desire of being comfortable, even when aided by limited means, will generally secure all the requisites that are necessary.

The chief condition to be observed, in the construction of these, is to make every other consideration subservient to utility; for, in fact, there can be nothing really ornamental, especially about the class of buildings which is now under consideration, that is not founded on this basis; and the size, style, and character of the building, are to be modified according to the pecuniary means available for its construction. As general rules in the erection of farm-houses, it may be observed, that it is always desirable that they should be placed upon a platform or terrace, with a view of keeping the ground floor of the several apartments dry, and consequently rendering them warmer and healthier; that the chimneys should be placed in the interior walls rather than in the exterior ones, this arrangement being better calculated to retain the greatest portion of the heat coming from the fires within the house; and by the additional heat contained within the central mass of masonry, to make the flues draw better; and that the ground plan should approach as near as possible to a square, as being that form which is calculated to afford the greatest accommodation with a given amount of expenditure.

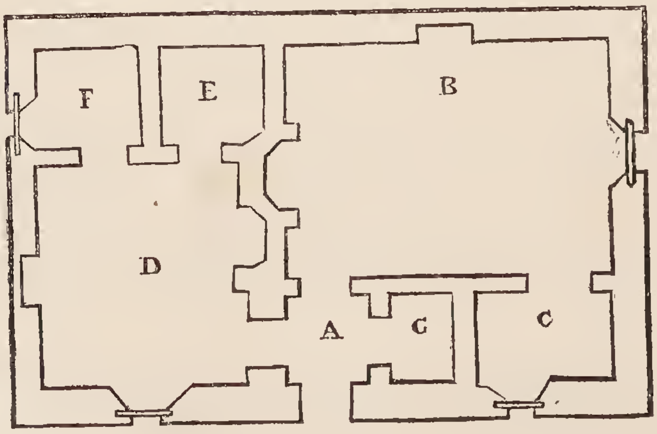
Keeping these principles in view, and accommodating them to the particular situation in which the structure is to be erected, every intelligent farmer will easily make out such a form and arrangement as may suit his peculiar circumstances. As a model for the construction of a farm-house containing suitable accommodation for a farmer of the better class, the annexed plan may be referred to. From the entrance and staircase, A, there is a kitchen, B; with back-kitchen or scullery, C; and pantry, D. There are two good parlours, E and F; a storeroom and cellar, G, which may be connected with the kitchen, or entered from the outside, as may be thought necessary. The three small apartments, H, I, K, may be used as storerooms for some of the smaller implements. It will perhaps be convenient that one of them should be a water-closet, and another may be fitted up as a carpenter's workshop, in which such jobbing may be done as the persons employed on the farm can do, and thus save the time occupied in carrying the articles to the workman. On the second floor there are three good bed-rooms, one above the kitchen, and the others above the front rooms, with a dressing closet over the entrance. The apartments on each side of the kitchen have lean-to roofs, and are not carried to the height of the other parts of the building.

Fig. 30.



The ground plan of a house consisting of one story only, and calculated for the accommodation of a small farmer, or cottager, is represented in *Fig.* 31. From the vestibule, A, a door leads to the

Fig. 31.



kitchen, B, from which is partitioned off a small bed-room, C. The bed-room, D, has a dark closet, E, and a light one F. The small apartment, G, may be used as a storeroom, in the ceiling of which there may be a trap-door, with a suitable ladder reaching to the roof, in which may be two sleeping apartments.

V.—ARRANGEMENT OF THE FARMERY.

The several buildings of the farm have been separately noticed, and we now come to consider the manner in which they are to be arranged in the farmery. As a whole, it may be considered with reference to its situation on the farm; its extent and character relatively to the size of the farm, and to the kind of culture pursued or crops raised; and its position relatively to that of the farm-house.

For the economy of labour, the buildings of the farm should be situated as near as possible to the centre of the cultivated grounds; for most of the produce being, in the first place, conveyed to the farm buildings, and the manure carried from them to the fields, it is important that the parts of the farm should not be so distant from the farmery, that time shall be wasted by the men and working cattle in travelling. A central situation reduces the labour of carting home produce and carting out manure to a minimum.

But although a central situation of the farm buildings is as much as possible to be aimed at, it is often necessary or expedient to sacrifice this convenience, in order to secure others. A primary object, for instance, is the obtaining of a sufficient command of water for domestic purposes, and the use of the live stock; but this cannot be obtained in every situation, and convenience of position, therefore, in the buildings, must often be sacrificed, in order to obtain the necessary supplies of water. Sometimes water can be procured in sufficient quantity by sinking wells; but it is always better that it be obtained by a constant flow or current, that the stock of the farm may be supplied at all times without the labour of pumping. Where a brook or rivulet of any kind does not exist, water can be frequently conveyed to the buildings by means of pipes; and when farm buildings are to be erected, a preliminary examination of the means of procuring this necessary article must never be omitted. Besides the supply of water for domestic purposes, and the use of live stock, it is often important to have it in sufficient quantity for a water power. However beneficial, then, it be to place the farm buildings in a central situation, this object must be often sacrificed to gain other advantages.

The size of the farmery, and the kind of buildings which compose it, must necessarily be regulated by the extent of the farm, and the kind of culture pursued on it. On a large farm the accommodation must be proportionally extensive, in order that it may be complete ; and when the farm is smaller, not only may the different buildings required for the larger one be diminished in size, but several of them may be dispensed with altogether. It is to be observed, however, that although on the smaller class of farms the same accommodation is not required, as on those of the larger kind, yet the buildings cannot be reduced in proportion to the diminished size of the farm. Small farms, accordingly, always require a greater comparative extent of accommodation than large. On farms chiefly appropriated to the rearing of stock, comparatively few buildings are required ; and these being chiefly sheds for shelter to the young cattle, and low sheds with yards for penning sheep when required. On a farm situated near a large town, the buildings must also be suited to this peculiarity of situation. Here the rearing and feeding of live stock may not be carried on at all, and only the raising of vegetable produce for sale be attended to. The buildings required on such a farm need be few and simple. No feeding and shelter sheds are required, and there is no need for that extension of the range of buildings which is necessary in the case of a rearing and breeding farm.

The most convenient disposition of the out-houses of a farm, suited to a mixed system of tillage and the rearing and feeding of live stock, is in the form of a long rectangle, or a square, as the case may be, open at one side, generally to the south, so as to admit the air to the cattle in the yards, and allow sufficient sunshine to them in winter. Sufficient space is to be appropriated to the several buildings and yards of the farmery ; for a few square yards more, occupied by the buildings, are of little value, compared with the inconvenience which results from having them placed two closely together.*

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* Elements of Practical Agriculture, pp. 622, 623.

The farm-house sometimes forms part of the rectangle formed by the farmery, but it is better, in most cases, that it should be detached. It should be placed on the south or open side of the farmyard, and some of the windows in the rear of the house should be so arranged that a full view of the proceedings in the yard may be obtained from them. This is of more consequence than might be supposed, it being well known that the superintending eye of the farmer or some of his family has a great effect in increasing the vigilance of servants.

In giving designs of the arrangement of the several parts of the farmery, little more can be done than to present useful examples. Although a certain similarity must exist in the form and arrangement in the parts of all such buildings, yet these, it has been seen, must be modified according to the circumstances of the farm itself, the nature of the soil, the situation with regard to markets, and many other particulars. No rule that can be given is of general application; and the judgment of the architect must be shown in adapting the size, form, and arrangement of the buildings, to the nature of the farm and wants of the occupier. While every suitable accommodation should be afforded to the tenant, it is the province of the architect to take care that the heavy cost of such buildings be not unnecessarily enhanced, either by erecting such as are useless, or by giving unnecessary dimensions to those that are requisite. It may be particularly remarked, that the giving of unnecessary breadth to the buildings adds materially to the expense, by increasing the dimensions of the timbers, and adding to the size of the roofs. At the same time care must be taken that, in the buildings for the accommodation of live stock, the animals shall not be injudiciously confined for want of room.

In the designs which follow, uniformity has been studied wherever it seemed to be practical, without interfering with convenience of arrangement; but when these qualities could not be combined, the preference has been given to the latter; and nothing has been proposed but what has been found, from experience, to be useful and practicable. It may be remarked, however, that it is quite impossible, especially in the larger class of farm buildings, to get the different apartments arranged so conveniently as could be wished, consistent with any degree of regularity. The number of designs might be multiplied to any extent, but it is conceived, that the three which are given here will sufficiently illustrate the plan of arrangement for situations and circumstances similar to those for which they are intended. They consist of—

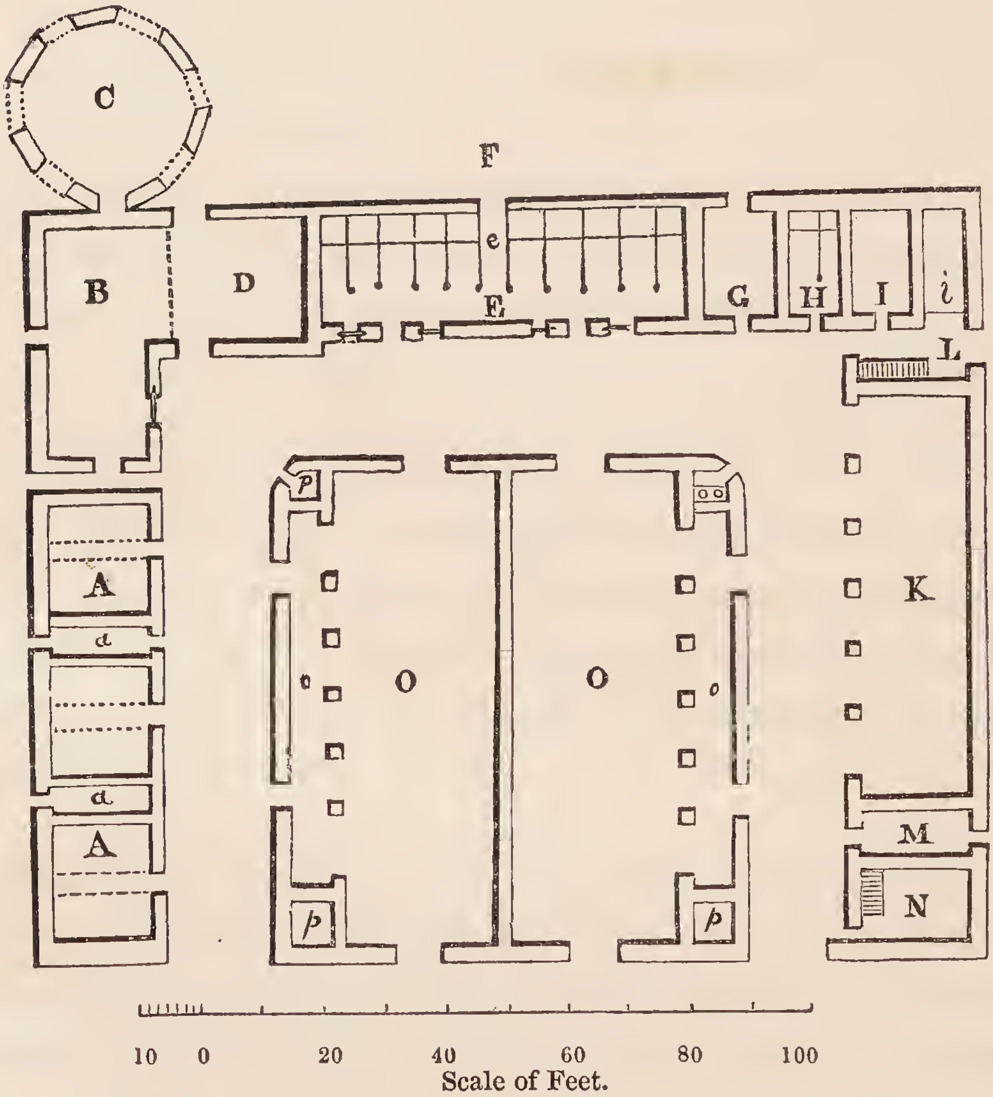
1. A design of a farmery for a farm of 150 acres, on which a seven-course rotation is practised, the grass division being pastured the second year.

2. A design of a farmery for a farm of 150 acres of arable land, suited for the growth of turnips.

3. A design of a farmery for a cottage farm of 25 acres.*

The ground plan of the first of these designs is represented in *Fig.* 32. Here A A A are cow-houses, with foddering bays, *a a;* B the

Fig 32.



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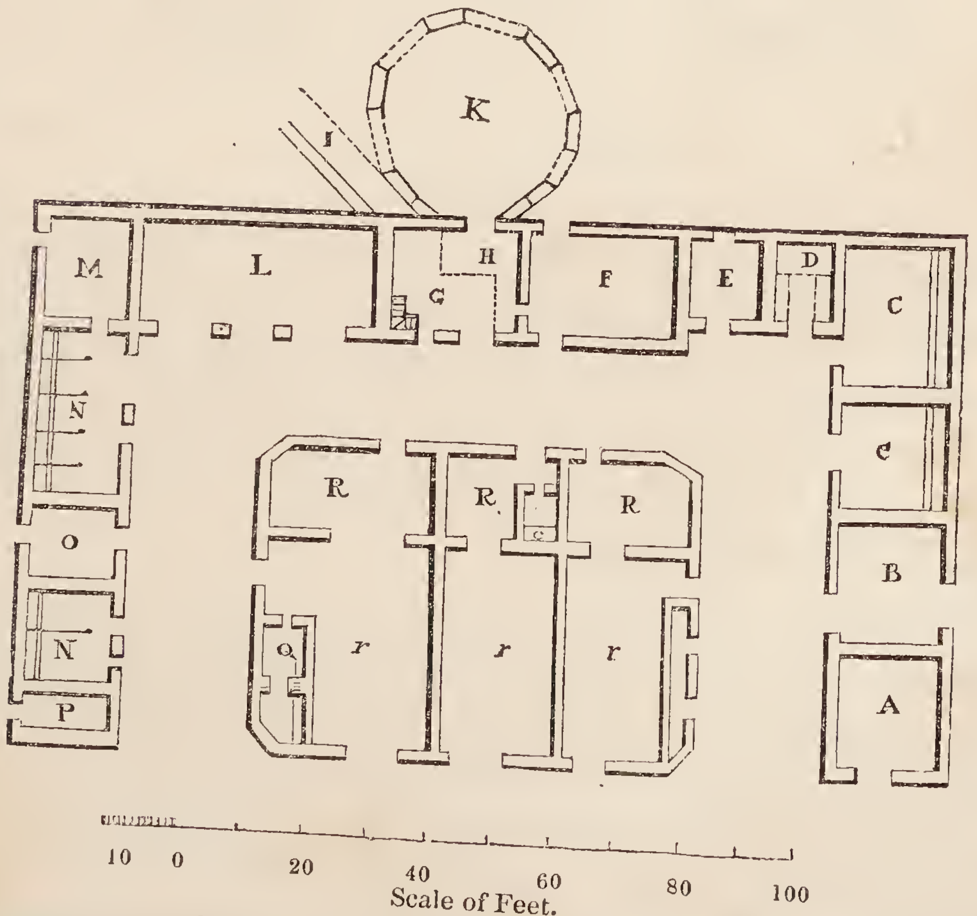
* The first of these designs is selected from Loudon's Encyclopædia of Architecture, and the other two are taken from a collection published by the Highland Society. See Prize Essays and Transactions, New Series, vol. ii. pp. 383-388. For further information on this subject, we would refer the reader to the former elaborate and very valuable work, from which several of the preceding plans have been selected, with the remarks accompanying them.

barn, with a horse-course for the thrashing machine, C, and straw barn, D; E stable for ten horses, with foddering bay, *e*, to which there is access from the stackyard, F; G house for potatoes, turnips, or grass; H stable for two horses; another cow-house, I, so arranged that the animals are fed from the front, by means of the passage *i*; K cart shed, with granary over, which is reached by means of the staircase L; carpenter's-shop and implement house M; spare room, with a place for poultry over it, N; O O the cattle yards, with open sheds, *o o*; and piggeries, *p p p*.

In this design, the walls are to be of stone, and the roof is to be slated. All the door-ways and window-openings have facings, sills, and lintels of dressed stone, and all the doors are hung by strap hinges, on hooks leaded into the stone, and they shut into rebates in the jambs. The feeding houses and stables have ventilators in the roof; one upright tube, about a foot square, with a cover to protect it from the rain, being placed in the ridge over every fourth stand. In situations where proper stones for dressing cannot be easily procured, wood or brick must be substituted.

The accommodation afforded by the second design is seen in *Fig.* 33,

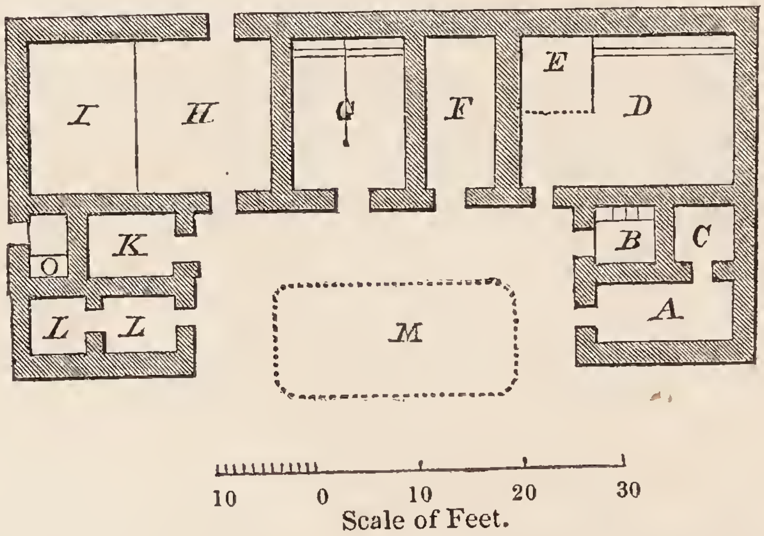
Fig. 33.



which represents the ground plan of the farmery. It contains a potato house, A; house for storing a supply of turnips or grass, B; two cow-houses, C C; calf-house, D; house for mare and foal, E; straw barn, F; dressing barn, G; and machinery, H; gangway, or inclined plane to the corn-loft, I; horse-course for the thrashing machine, K; cart-shed, L; hay-house, M; stables, N N; spare house, O; poultry-house, P; piggery, Q; and shelter-sheds, R R R, with yards, *r r r*.

This plan will afford all the accommodation that could be wished for on a farm of the size for which it is intended. The form of a horse-course for the thrashing machine is given here as well as in the preceding design; for, unless sufficient water can be easily procured for turning a wheel, farms of this kind will not afford the expense of a steam power, and horses must therefore be employed.

Fig. 34.



The ground plan of the design of a farmery for a cottage farm of 25 acres is shown in *Fig.* 34. In it are seen a court for calves, A, poultry-house, B, open to the cow-house to partake of its heat; calf-house, C; cow-house, D; calf-crib, E; cart-shed, F; stable G; barn, H, part of which, I, is to be lofted over; potato house K; piggery, L L; and dung pit, M.

The propriety of ascertaining the practicability of communicating motion to the thrashing machine, by water, before finally determining on the proper situation of the farmery, has been already mentioned but, from some peculiarity of circumstances, a stream answering for the purpose may be found in a situation altogether ineligible, in every other point of view, for the erection of the buildings of the farm. In this case, it might be advisable to detach the barn from the other buildings for the purpose of effecting the thrashing of the grain by a water power; but it is to be remembered, that this arrangement is attended with the very great inconvenience of having the straw to remove to buildings placed at a distance; and it is, therefore, only in peculiar cases, that it can be advisable to carry it into practice.

A situation for the stackyard should be chosen adjoining the barn, and on the most elevated and exposed side of the farmery. Its size is regulated by that of the arable part of the farm, and also by the size of the barn; as the stacks are not to be made larger than what could be contained at one time by the corn-bay, or end for unthrashed corn; and, consequently, a small barn will require a larger stackyard than a large one. The form, in this case, as in almost every other yard or building of the farmery, ought to be rectangular, and as near as may be convenient to that of a square. The stacks are to be placed in parallel rows, with a sufficient space betwen them for a cart to pass along, either to unload when building the stack, or load when taking the corn to the barn. Round the stacks, on the margin of the yard, there should also be a space sufficiently wide for a loaded cart to pass; and, at the corners, this space should be increased by the omission of a stack, in order to admit of carts being easily turned round. The stacks are to be placed on stands, so as to keep them dry and free from the ravages of rats and mice.

The system of drainage in a farmery is a matter of very great importance, and it ought to be determined on before any part of the buildings is commenced. There are three distinct systems of drainage which must necessarily exist in every well-arranged farmery; the first is the underground drainage of the natural soil, so as to render it perfectly dry beneath, and fitted for serving as the immediate basis of the floors of the different buildings to be erected; the second is the surface drainage, for the removal of the rain water from the roofs and passages; and the third, the liquid manure drainage, for conveying the urine from the stables, and other buildings and yards in which the different species of live stock are kept, to the manure tank.

It seldom happens that the site for a farmery is so dry as not to require some underground drains around and through it, for carrying off the water that either sinks into the soil from the surface and is retained there, or is found latent in the subsoil, or from some other cause. In making these drains, particular care is to be taken that they be arranged so as to dry thoroughly the ground under the floors of all the houses; and at the same time, neither in the houses nor in the yards interfere with the drains to the manure tank, so as to carry off any portion of the liquid manure. For this purpose, and also because their object is chiefly to carry away underground water, they should be deep, and they need not come within a foot or more of the surface of the ground. In general, one drain should surround the farmery, so as to intercept all exterior sources of water; and others should cross under the principal lines of buildings, and roads or passages. The feeding yards will be rendered sufficiently dry by these drains for containing manure. As the drains under the passages, and in some other situations, will have to receive the surface water through traps, they ought to be barrel drains, but all the others may be formed of stones in the usual manner.

The water from the roofs of the buildings should be all collected by gutters at the eaves; and, if not wanted for a well or tank, it should be conducted directly to the underground drains through air traps. These traps are of such a construction as to retain the sand and grosser particles which might choke up the drain; and they are placed so as to be easily removed, to admit of the drains being readily cleaned out. The liquid matter conveyed through all these underground drains is to be conducted to a point where it may be rendered available, for the purpose of the surface irrigation of grass land.

A liquid manure tank is essential for retaining those parts of the manure which would otherwise flow out of the yards and be lost; and with this the drains from the stables, cattle sheds, and yards, are to communicate. These drains need be neither large nor deep; and they may, in general, be formed of brick, with a trap near the opening of each, to prevent the possibility of a current of air passing through them, and the disagreeable smell thereby occasioned. The manure tank may be of a very simple construction, the walls being built of stone or brick, and so formed as to prevent the escape of any of the liquid, in case of the surrounding earth being of a porous nature.

It should be covered over the top, and in the covering there is to be a hole through which the end of a pump can be inserted. The tank may consist of two separate apartments, in order that the urine and other matters may be kept for some time after being collected, as they are found to be thereby much improved.

V.—ENCLOSURES OF THE FARM.

I.—PRINCIPLES TO BE OBSERVED IN ENCLOSING LAND.

The object of enclosing land is obviously protection; and nothing contributes more to the comfort, the convenience, and the successful prosecution of the business of husbandry, than the proper subdivision of farms into suitable enclosures. When a country is entirely in tillage, it is of less importance that farms be divided into enclosures, separated by artificial barriers; but, wherever live stock are kept, this is essential to the proper keeping of the animals, and to the profitable occupation of the grounds; and, besides the purpose of retaining and separating animals of different kinds from one another, and of defending the cultivated crops from injury, fences serve the purpose of sheltering the fields, and, when accompanied by ditches, of draining the land.

The enclosing of land being a fundamental and important branch of agricultural improvement, the general principles on which it is founded, and the best method by which it may be effected, are essential objects of inquiry to the farmer.

It is seldom that possession of a farm is obtained which is not previously divided into enclosures of some kind. These, however, are often of such a description, both with regard to size and shape, and the nature of the fences by which they are separated, that it may be esirable to level the old fences in whole or in part, and adopt an arrangement more in accordance with the nature of the farm. When the fences are crooked, and occupy a large space, either by the spreading of bramble, or by large earthen banks, the better plan is, to remove them at once, even were they situated in the proper place, and form new fences in their stead. How far the occupier is justified in removing the old fences of the farm, and supplying their place with others, must depend on the particular circumstances of the case, and cannot be ascertained without reference to them.

The object which first claims the attention in commencing the enclosing of lands is the nature of the soil. Every species of soil is improved by being enclosed. The nature of the soil prescribes the system of husbandry to be adopted, and that system regulates the number and size of the enclosures. On the richer class of soils pasturage is sometimes not practised, the land being in constant cultivation, and there, it has been said, enclosures are not so essential; but they are absolutely necessary on all the inferior class of soils of every description. Shelter by enclosing is also necessary for the welfare of live stock on mountain pasture. That obtained from large masses, or even belts of planting in upland districts, improves the climate in a sensible degree; prolongs the duration of food by encouraging the growth of grass, both early and late in the season; and protects the live stock from many diseases incidental to exposure in wet and cold weather. When there are great variations in the nature of the soils to be enclosed, it will be proper to separate the light from the heavy. They are not only better calculated for different crops and different rotations, but are naturally adapted to be cultivated at different seasons. It is unfortunate, therefore, to have soils of a heterogeneous nature in the same field. When a small part only of a field differs greatly from the remainder, the constituent parts of it may be so altered by admixture with the other part, as to nearly assimilate them in quality.

Having ascertained the nature of the ground to be enclosed, the next points demanding attention, are the position, shape, number, and size of the enclosures to be made. These properties of enclosure depend on the nature of the soil, the aspect of the ground in regard to inequalities, and the rotation of crops suited to the soil.

The position of an enclosure mostly depends on the aspect of the ground, and it is ascertained by the direction of the ridges which it contains. The ridges should always, if possible, run north and south, to permit both sides of them to derive equal benefit from the solar rays. On flat ground this direction may be easily secured; but the inclination of uneven ground may be in an opposite direction; and as surface water may engender more evils to land than the solar says can confer benefit on both sides of the ridges at the same time, the ridges should follow nearly the inclination of the ground, to secure a rapid exit to the water. When there is any considerable declivity, the length of the ridges, and consequently that of the fields, should be comparatively short, as currents of water would be so much increased by the length of their course, as to carry a great portion of the finer particles of the soil off the land; and, in ploughing, the horses would be too much fatigued by a long furrow up the hill. These objections to long ridges are, however, in some degree, obviated by giving them, in such situations, a certain degree of obliquity in ascending the hill.

The shape of enclosures is chiefly regulated by the nature of the soil. It is demonstrable that the shape which contributes most to economy in the labour of a moderate-sized field, is the square; and in the case of small farms, where the fields are necessarily small, the oblong rectangle is to be preferred. Frequent turnings of the plough occupy much time; but, on the other hand, an inordinate length of ridge, to obtain few turnings, fatigues the horses beyond their strength. The strength of the animals of draught is, in this case, the measure of the greatest length of ridge, to secure the greatest economy of labour in ploughing the field. The corners of fields should be right-angled; because the plough can turn over more of the ground in four square corners of a field, than in two acute and two obtuse angled corners.

It is an essential requisite in the dividing of farm lands to have the fences of the fields placed parallel to each other. The advantage of this arrangement is unquestionable, as an opportunity is thereby afforded of carrying on the operation of cross ploughing, when necessary, as well as that of ordinary ploughing, with the greatest facility; and wherever this parallelism is neglected, wedge-shaped ridges, or, as they are technically termed, points, must be thrust in somewhere to equallize the field; and the ploughing of these ridglets consumes much more time, than ploughing an equal space would, under other circumstances. The suitable place for these truncated ridges is at the boundaries of the farm. To preserve neatness and uniformity in ploughing fields, all fences should run in right lines. A fence running in a straight line along the summit of an elevated piece of ground affords excellent shelter on both sides. Indeed, a fence occupying elevated ground secures more shelter to fields than in any other situation; and, on that account, if other circumstances will permit it, the elevated summits of rising ground may be advantageously chosen as the sites of fences. But it sometimes happens, that the lower ends of fields cannot be enclosed in a straight line, a rivulet or hollow between two rising grounds frequently terminating their lower ends. In that case, the fence ought to follow the course of the water or hollow ground, in order to provide the means of ready egress for the surface water coming from both sides. A serpentine fence in a hollow, contrary to one on a rising ground, affords more shelter than a straight one, in the direction of the wind, which almost always takes the direction of the valley. A public road or canal passing through a farm, or stripes of plantation growing in it, affect the laying out of enclosures. Whether any of them exists before or after the land is enclosed, the irregular sides of the enclosures, which alone should contain points or truncated ridges, should be placed next the obstacle. It may be proper here to mention, that a public road is a great acquisition near enclosures, as it may save the making of more than one private one. Easy access to and from the fields to roads, is an important means of preserving the health and strength of horses, and of saving the tear and wear of carriages and harness.

The number and size of the enclosures must obviously be regulated by the size of the farm, and by the rotation of cropping practised on it. It is a general rule to divide the farm according to the rotation ; that is, a farm on which the six-course rotation is adopted, should have six enclosures. It is proper to have a whole field in the same description of crop, and to have the produce of the farm every year as equal as the soil and season will admit of ; and this can be obtained only by having the enclosures of an equal size, and adapting the number of them to the rotation.

When the four or five years' course rotation is adopted, the farm is then conveniently laid off into four or five divisions; but in the case of large farms, the fields would be of an inordinate size, and eight or ten divisions, or fields, will suit the rotation equally well, two of the fields being in the same sort of crop. Placing the same kind of crop, particularly green crop and grass, in moderately-sized fields, in different parts of the farm, almost insures a good crop in one of the situations ; and the labour bestowed on any kind of crop, being for the time confined to one moderately-sized field, probable secures a favourable seed-time and harvest to that field; at least, the risk arising from a change of weather, which affects labour as well as crop, is, in a great degree, avoided. A very obvious advantage attending this arrangement is, that it tends to equallize labour. On large farms, where all land under clover or turnips, for example, is near the extremity of the grounds, or at a considerable distance from the buildings of the farm, it is clear that the labour of supplying the cattle with these bulky crops, as well as the carriage of manure to the fields, is much greater than if the fields were so arranged that the half of each of these crops should be situated more convenient to the homestead; and by means of there being two fields for each crop in the rotation, it is easy to connect one field thus conveniently situated with another at a greater distance.

But the advantages of this arrangement are not confined to the equallization of labour; it may also, in a great measure, render the annual produce of the farm equal and uniform, notwithstanding a considerable diversity of quality in the soil. A field of an inferior soil may be connected in the rotation with one that is naturally rich; and in the consumption of the green crop, as well as in the application of the manure, the poor land may gradually be brought nearer in the quantity and quality of its produce to the rich, without injury to the latter. Thus, a field under turnips may be so fertile that it would greatly injure the succeeding corn crop to consume the turnips on the ground; while another may be naturally so poor or deficient in tenacity, as to make it inexpedient to consume any considerable portion of the crop elsewhere. Two or three small enclosures near the homestead, of from half an acre to three acres each, are indispensably requisite on every farm on which live stock is reared. They may be used for tups when out of season, calves or lambs when weaning from the milk, ewes when lambing, for a mare and foal for a few weeks, till the mare has recovered her strength, or as convenient places for sick and convalescent animals, where they can remain undisturbed. Should a smaller portion of grass or green crop be at any time required, a temporary fence can be erected in preference to dividing the land into permanent small enclosures.

Mountain pastures, which are exclusively devoted to the use of live stock, should be enclosed in large divisions. Cattle and sheep are generally reared in mountainous districts in great numbers. The live stock of the mountains possess more active habits than those of the plains; and as the herbage of the mountains is always rather scanty, they require a larger space to roam over to collect their proper quantity of food.

Access to good water should never be overlooked, though it too often is, when land is enclosing for live stock. Should a rivulet not be within reach, spring water should be obtained for cattle, either by sinking wells or laying conduits or pipes. The best pasturage as food will never improve the condition of cattle to the extent of which it is capable, without the digestive aid of plenty of good water. Without an abundant supply of water, fields of the best grass will lose much of their value for grazing cattle, though they may answer for sheep.

The enclosures of the farm should be separated by fences suited to the situation, and combining economy with permanence and utility. Closely connected with a convenient arrangement of the fences of the farm is the proper situation and construction of field gates, which give an air of order and neatness to the farm. This branch of farm management is little attended to by the small farmer, and the entrances to the fields commonly consist merely of an opening made in the fence, and defended only by a number of large thorn bushes, or perhaps by a plough or cart, or any other implement that may be convenient.

The situation of the gate should be in the middle of that side of the field which is nearest the road leading to the farmery; because, in carting home produce and carting out manure, the labour is less on a well-formed road than on the soft ground of the field, and carting also more or less injures the ground. When the entrance to the field is situated near a corner of it, the headland is cut up and injured by the frequent repetition of the carts in the same track; and this will be avoided, as far as possible, by having the gates placed near the centre of the fence forming the near boundary of the field.

When a public road passes through the farm, entrances to the fields may be made from it; but in the case of large farms not thus advantageously situated, and especially in the case of clay farms, such roads must be formed as will secure convenient access to every field. On wet and clayey soils these roads must be formed of durable materials, otherwise access to the fields is impracticable during the winter months; but on dry soils, provided attention is paid to fill up the cart ruts, as they are formed, with small stones, gravel, or even earth the surface of the road will seldom require to be formed of any other material than the soil itself. It is essentially necessary that a piece of a road should be formed at the entrance to the fields, that being the spot which is most frequently subjected to injury. Without this precaution it often becomes a mire, where corn is thrown down and spoiled in the harvest; or if it is attempted to avoid the mire, the gate posts and adjoining fence are often damaged.

The drainage of farm lands should be attended to in laying off the fences, so as, if possible, to make the ditches of the latter serve as open drains, as in this way the expense of draining may be greatly lessened. The practicability of conveying streams of water for irrigation, or for machinery, should also be attended to, as the situation of the fence may, in some measure, depend on this circumstance.

II.—CONSTRUCTION OF FENCES.

The fences of the farm may consist of hedges, usually termed live-fences, or of earthen banks; or, as is more frequently the case, of a combination of the hedge and earthen bank. In elevated situations where stones are procured in abundance, and where the live-fence is reared with difficulty, stone walls may be erected to supply the purposes of a fence. In addition to these, fences are sometimes formed of wooden or iron railing; but these are either for immediate or temporary uses, or for fencing in parks and scenery when an air of lightness and freedom is a desirable object. Iron railing forms a durable and elegant fence, occupying but a small space of ground, but it is so expensive as to prevent its being used for the purpose of the farm. That formed of wood serves the purpose equally well, but it is wanting in durability and apearance, when compared with railing of iron.

Various plants have been used for the purpose of forming the live-fence, both separately and combined; but in general the common hawthorn, *Cratægus oxyacantha*, is the most esteemed. Like all plants raised from seed it produces numerous varieties, some of which are much more abundantly furnished with prickles, and some grow faster than others; and hence it might be desirable to save the seeds of fast-growing prickly plants. In common with all the ligneous plants of the natural order to which it belongs, the hawthorn grows readily from cuttings of the roots.

The plants may be raised from seed, and this is the way in which those intended for hedges are produced; but the process is so slow, from the great length of time which the haw is in the ground before germination takes place, that it is seldom employed by the farmer, and they are therefore procured from the public nurseries. They are taken from the nurseries when they are two or three years old, and at this age they may with propriety be placed in the situation in which they are ultimately to remain ; but it is better to use plants of more advanced growth. As thorns are, in general, planted too thick in the beds of the nursery, in order to save room, and force the plants into a premature growth, it is advisable that they should be removed from that situation when they have been two years in the seed-bed, and transplanted out in lines of ample space, in a spare piece of ground where the soil is deep and free. By this process the stems will acquire a cleaner bark and greater strength, and the roots will be covered with an additional number of rootlets or fibres; the constant effect of transplanting being to cause the production of numerous short fibrous roots. The freedom and celerity with which the plants will grow after this preparatory process will amply repay the additional trouble and expense ; and it should be neglected in no instance where it is desirable that a good and efficient fence should be raised in the shortest time.

Whether the plants are placed in any intermediate situation or not after removing them from the nursery, and before planting them in the fence, their roots must not be unnecessarily exposed to the atmosphere, otherwise the vegetative principle will be greatly injured, or altogether destroyed. As soon, therefore, as they come from the nursery, they should be taken out of the parcels in which they are there packed, and put into the ground in rows, the earth being firmly placed about their roots.

It has been said that there is no impropriety in using plants only two years old, further than the greater length of time which must necessarily elapse before they form a useful and efficient fence. Plants of this description, when planted at a proper season of the year, upon land well prepared, and afterwards carefully kept clean, seldom fail to make a good fence. Such young plants are, however, it is to be observed, long in a state of infancy, and require much care, and the most complete protection, to bring them to perfection, and are liable to be much injured or totally destroyed by many accidents that would produce little effect on stronger plants. Much time might be saved in the rearing of hedges, and the fences be much more perfect and useful, if older plants were employed. Three years old is certainly the youngest that should be planted, and if the thorns are even much older so much the better. The prevailing idea, that plants of that or a more advanced age will not thrive if transplanted, is entirely unfounded.

The preparation of the soil for hedges is one of those points intimately connected with, and essential to, their success. It were unreasonable to suppose that hedges will grow luxuriantly, and soon become fences, if the ground on which they are to grow be not previously prepared for their reception. Except in a very few instances, however poor the soil may be, or however strong the cohesion of its parts, no attempt is made either to break that cohesion by tillage, or to improve the quality of the soil by enriching or alterative manures. The young plants are, for the most part, laid upon the old surface, and their roots covered by the earth used in forming the bank.

When the hedge is to be planted on land that has been under the usual course of cropping of the farm, no further preparation is necessary, as to fallowing and cleaning it. But when this is not the case, the ground upon which the thorns are to be planted should undergo a complete preparation, by deep ploughing or trenching with the spade, and by the application of a liberal allowance of manure.

Having fixed upon the line of the fence, it may be laid off by means of poles, like the ridges of a field, and marked upon the ground. Should the surface of the ground present no inequalities, it can be laid off with great accuracy in a very simple manner; but should an elevation or a hollow, however small it may be, intervene, great care is necessary to preserve the straightness of the line, otherwise the fence may be made to advance upon the true line in the hollow, and recede from it on the elevation. If the line of the hedge runs across ridges, at whatever angle to them, the furrows are to be made up to the height of the crowns of the ridges, and the unequal shrinking of the earth will cause the line of the fence to be either raised or depressed at the furrows, and perhaps to vary a little to either side, unless the utmost care and attention be paid in performing the operation. The instruments used are a common reel and line, and a rule of wood of about six feet in length on which feet and inches are marked, with a piece of wood fixed at right angles to one end of it, so as to measure off with facility the breadth of the ditch in a direction perpendicular to the line laid down. Three poles, such as are used for marking off ridges, will be required for laying off the line of the fence. The instruments used in the execution of the work consist of a common spade and shovel, a mattock, and a foot-pick.

The poles being placed in a right line, in the direction of the intended fence, one end of the cord is fastened firmly in the ground at the point at which the fence is to begin, and it is carried along in the direction of the poles until the cord is all wound off the reel, when the other end of it is also securely fastened in the line of the fence. It is of importance to observe that the line or cord runs exactly along the bottom of the poles; and should any obstacle interfere with the adjusting of the line, such as twigs, tufts of grass, stems of plants or shrubs, or stones, they are to be removed by the spade. As the least obstruction on the surface of the ground will cause the cord to deviate from a right line, it should be lifted up about three feet high, and let fall suddenly to the ground, when it is probable it will lie straight. Stones may now be placed at intervals on the cord to prevent it from changing its position, and the line of the fence is to be marked off by the spade, the workman standing on the ground on which the fence is to be placed. The rule with the cross head is then used for laying off the breadth of the ditch,* which is to be marked in a number of places by pins. Along these pins the line is again stretched, and it is marked by the spade in the same manner as the other side, the workman standing with his face in the opposite direction. A sod is now raised along the line marked for the thorns, and laid over on its back, it being well beat down by the back of the spade, and its near edge so placed as if it were a continuation of the inclination of the side of the ditch. It is upon this sod or raised portion of earth that the thorns to be planted are laid. A further portion of the surface of the ditch is taken up, and placed immediately behind the thorn bed, or place intended for the plants. The sod first raised and inverted should be as entire as possible; but the more comminuted the others are, it is the better for the vegetation of the plants. A vertical section of the work, after this process, will appear as in *Fig*. 35.

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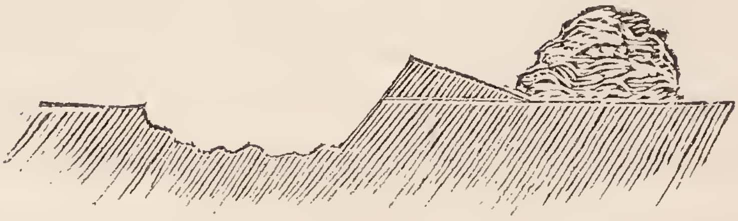
* Much confusion is often created by the misapplication of the terms *ditch* and *dike*, the former being used indiscriminately to denote both the hedge-bank and the excavation from which the bank is formed; but it should be confined to the latter signification alone.

Fig. 35.



The thorn plants, as they are taken up from the ground, must be prepared for planting by cutting off the tops. To accomplish this the plant is grasped firmly by one hand immediately above the root, while, with a sharp knife, the stem is cut through by a cut inclining upwards, so as to leave, exclusive of the root, about four inches of the stem. The plants are not to be taken from the ground until the place in the fence is prepared for their reception, and every precaution is to be used to protect them from frost, which often occurs at the season in which hedges are planted.

When a sufficient space of ground is ready for being planted, and the plants prepared in the manner described, they are placed firmly on the thorn bed, the stem inclining upwards, and projecting a little from the face of the bed; and it is well that the roots of the plants should be dipped into some liquid, such as water or urine, among which a portion of earth is mixed to cause more of the substance to adhere to their roots. The distance between the plants will, in some degree, be regulated by their size; the smaller plants may be placed on the thorn bed four or five inches apart, and the larger ones six or eight inches. Close following the planters are persons throwing earth from the ditch, on the roots of the plants, and that taken from near the surface of the ground should be chosen for the purpose, as being more favourable to their growth. A covering of a few inches in depth will be sufficient to protect the roots from the frost; but it is better that a good covering should be given at this time, to protect the plants from injury in the event of the workmen being engaged for a length of time at any other work. After the roots of the plants are thus covered, the planter should go over the whole again, to compress the earth about the roots of the plants, and to adjust those that may have been removed from their proper places.

The usual practice is to carry forward all the work to this stage before any part of the banks is completed. This enables the workman to get the plants into the ground at a proper time, which is essential to the success of the hedge. When the process of planting is finished, the remaining part of the bank is completed with the earth taken out of the ditch. In performing this part of the work, it is to be observed that the surface of the bank must have a smooth and uniform appearance. This is effected by paring down any irregularities that may appear with the spade, and by beating the earth well to compress it with the same implement. The surface of the bank is formed of the earth taken from the bottom of the ditch, which is more suitable for the purpose than earth of a good quality, being inimical to the growth of weeds which would otherwise take root and vegetate, and greatly injure the plants of the hedge.

The dimensions of the bank thus formed will necessarily vary according to those of the ditch from which the earth is taken. It is, in general, better that the bank should be small, for otherwise the vegetation of the plants will be retarded, the air and moisture being kept from their roots. The ditch must be so laid out and formed, as to permit the descent of water, and the sides of it are to be carried down in such a slanting direction, as will prevent any part of them from mouldering down from the effects of frost. Where a stream of water is to run along the ditch, it must be made proportionally capacious; for if not made so at first, the force of the stream will soon make way for itself, and probably endanger the thorn bed. Where there are slight inequalities, the ditch must be made deeper at one part than at another, and, in some cases, the earth is taken away from the place where the ditch is deep, to make up the bank where it is shallow; and it will often be found necessary, that the water should be carried away by a drain cut through the mound of earth, and underneath the thorn bed, into the adjoining field.

Thorns may be planted at any time, from October to April, that is during the period when vegetation is inert. The autumnal season is preferable, as the plants are then ready to push forward in the earliest spring: the months of January and February are also well suited for the purpose; but March and April are rather late, particularly in the case of dry soils, in which the young plants frequently suffer from drought. A southern and eastern aspect should be preferred, if possible, for the plants.

Thorns are sometimes planted on the top of mounds of earth, slightly raised above the surface, and having a ditch of smaller dimensions on each side. This mode of planting is suited only to dry lands, and it has not any advantage over the plan which has been described, being as difficult to form, occupying a greater space of ground, and being more difficult to preserve the hedge plants from the attacks of animals. The thorn plants being placed in the slanting surface of a mound of earth is, indeed, the best plan of raising hedges; for, when thus set, they are placed in a manner favourable to their growth, besides the ditch on one side, and the earthen bank on the other, serve to defend them from injury.

The period when the land is in grass is that most favourable for the planting of thorn hedges; but, in this case, the plants are liable to be much injured by cattle attempting to go over the fence, and by their browsing on the young shoots of the thorns. The best time, therefore, to commence the work, is just previous to the conversion of the grass land into tillage, as, by the time that it is again laid down to grass, the plants will have attained to a size in which, if they do not form an efficient fence, they will, at least, be less susceptible of injury than in the earlier stages of their growth.

But frequently, in addition to the protection afforded to the plants of the fence by the bank and ditch, further protection becomes necessary to secure them from injury. A simple and convenient protection is a paling formed of wood, placed on the top of the bank. This consists of two or three horizontal rails nailed to, or mortised in, post or stakes placed vertically, and driven into the ground. Two horizontal rails are sufficient for fencing off cattle, but three will be necessary for sheep. The rails are formed of poles, generally of larch or spruce, sawed into two or more divisions, according to their size. The upright posts are placed about seven or eight feet apart, and driven such a length into the ground as to prevent cattle from rubbing them down; and to give additional security, the rails should be placed on the side of the stakes next to the field, where they are fastened by nails. The rails are usually of such a length as to extend over the spaces between two of the uprights, and, in this case, the ends of all the rails should not be fastened to the same upright; nor should the root, or thick ends of the rails, be nailed together, but top and bottom ends alternately, as the weight of the rails is thus more equally supported by the different stakes placed in the ground.

Another mode of protecting the thorn plants, and a very common one in this country, consists in rearing another hedge of whins on the top of the mound. The whin, indeed, seems well suited for this purpose, as, from the rapidity of its growth, it becomes a complete fence in the second year after it is sown. The whin seeds are sown on the top of the mound immediately after it is formed, and while the earth is still fresh and moist. A pound of the seed will sow 250 yards, and the season of sowing is the same as that for planting the thorns; but in the case of autumnal planting, it may be better to defer sowing the whin seed until the spring. The whin does not form a good permanent fence, being of short duration; but this circumstance does not affect its utility as a temporary protection to another class of plants. The whins should be pruned every year, in the month of June, to prevent them from overshadowing the thorn plants, and also to prevent the production of seeds, the dispersion of which over the adjoining lands would cause much annoyance. The roots of the whin spread to a great extent, and penetrate into every part of the mound; they would, therefore, if allowed to remain, interfere with the growth of the thorn plants, by depriving them of a portion of the nutrient matter of the soil, but they are removed when the latter are so advanced as to require no further protection.

The hedge being planted, and duly protected from the intrusion of the domestic animals of the farm, attention is afterwards to be directed to the management of it, until it forms an efficient fence. This consists of pruning and weeding the intervals between the plants.

During the first year of their growth, the plants will require little weeding, and no pruning. If the hedge has been planted in the autumn, the grass between the inverted sod and the original surface will have decayed so much as to give little trouble in the early part of the season; but, should the hedge have been planted in the spring, the vernal influence will keep alive the grass under the inverted sod, and it will grow rapidly, so that, it may be necessary to clear it away in the beginning of summer. This is done by means of the hedge spade, shown in the annexed figure. It consists of a handle about three feet long, and a blade from four to five inches broad. The weeder stands in the ditch until he has completely cleaned the part of the bank below the thorns;

Fig. 36.

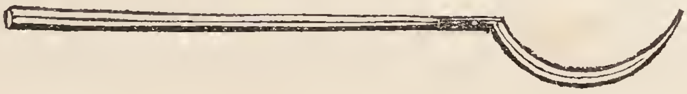
and, to clean the upper part, he proceeds along the top of the bank, working downwards. If the weeding process is delayed until the roots of the weeds have taken firm hold in the ground, the displacing of them carries away a great deal of earth from the face of the bank. All weeds should be carefully removed at least once every year, and generally twice.

In the management of live-fences, complete weeding, loosening the earth round the roots of the plants, and putting it up to them, are essential operations; for, whatever pains may have been previously taken to prepare the ground, unless it be afterwards kept clean, will be injurious rather than useful, inasmuch as it will tend to promote the growth of weeds, to the great injury of the fence. This part of the management of fences is almost wholly neglected by the Irish farmer, and the consequence of this neglect, in conjunction with injudicious pruning, is, that the hedges of the country have, in general, a miserable appearance, and are but little calculated to fulfil the purpose for which they are intended.

Pruning may commence in the second winter after the hedge has been planted; but, at that period, it must be performed with a very sparing hand. Such straggling side branches as are spreading out of the line of the hedge only are to be cut off. The main stems of the hedge should he left untouched, till they have attained the height of five or six feet, and the pruning confined solely to the side branches, leaving those next the root pretty long, and shortening them gradually towards the top. This pruning of the side branches will make them send out many new shoots from their extremities, which, by repeated trimmings, will become so thick as to fill up every interstice from top to bottom of the hedge; while the main stems, by being left untouched, continue their growth upwards, till they arrive at the necessary height, when they may have their extremities cut off with perfect safety. When a hedge has attained the wished-for height, all that is requisite afterwards is pruning the sides, preserving it broad at the bottom, and tapering gradually towards the top. Under good management, a hedge of this sort, in full leaf, has the appearance of a solid wall; and, when the leaves are shed, it presents to the eye a set of massive prickly upright columns, so strong and formidable, as to resist effectually all attempts to break through them.

Hedges are pruned with a light curved knife, *Fig*. 37. An instrument of this sort is readily formed by putting a reaping hook into a handle about four feet in length. By it the work is done with despatch, and in an effectual manner. Clipping hedges with shears is much practised throughout the country, but this plan is merely mentioned, that it may be condemned, as being far inferior to pruning with the knife.

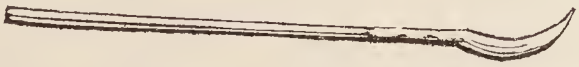
Fig. 37.



In the management of the hedge, it is of importance that it should be kept broad at the bottom, and tapering towards the top, a vertical section of it thus forming a wedge. When the thorns are allowed to grow up with a close branching top, they will be found invariably to present a mass of naked stems to the eye, but ill suited to the purpose of a fence. Cutting over the tops of the thorn plants causes them to send forth a profusion of shoots there; but when the pruning knife is confined chiefly to the sides, the hedge will continue close at the bottom.

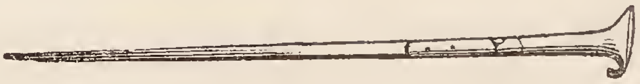
The most effectual plan of restoring a decayed hedge to a proper shape and vigorous growth, consists in cutting it over, the height being denoted by the previous state of the fence. In general, it is advisable to cut over the stems to within a few inches of the ground, and a number of fresh and vigorous shoots will soon spring up from the stumps, and form a close and elegant fence. The instrument used in this operation is a knife, or, as it is generally termed, a bill-hook, *Fig.* 38; and it is of importance, that knives of different sizes should be employed, according as the stems to be cut are thick or small. In cutting down the thorns, the workman stands in the bottom of the ditch, and by repeated strokes of the hedge knife, in a slanting direction upwards, cuts through the thorns. The knife is grasped in such a manner, that the workman can give it the full swing of his arm, in order that he may strike with the greater force. In the case of some of the larger stems, it will be necessary, after giving two or three strokes in a slanting direction upwards, to strike the stem a

Fig. 38.



short distance above the former incision, in a contrary direction, by which a wedge-shaped piece of wood is taken out of the stem; and the workman is enabled to proceed in the cutting of it down with greater despatch. The smaller stems and branches will be cut through by a single stroke, and for some of the larger ones a light axe with a long handle may be used instead of the hedge knife. All branches and bramble, spreading out from the stems, are to be cleared off before proceeding with the work. As the stems and branches of the hedge interlace each other, they do not fall down when cut; and to enable the operator to drag them down without having his hands injured by the prickles of the thorns, a hook, to take hold of them, may be formed on the extremity of the hedge knife, as shown in *Fig.* 39. With this hook he pulls the end of the stem that has been cut off towards him, in order to seize it with the left hand, which, having done, be pulls asunder the tops, with the assistance of the knife, and then lets the thorn fall gently out of his hand against the bank.

Fig. 39.



Instead of cutting off the stems close to the surface, they are sometimes cut at the height of two or three feet, under the impression that they will sooner become a fence. Except when they are growing with the greatest regularity, it will seldom be advisable to adopt this plan, as the thorns have a tendency to send forth a profusion of shoots from the place at which they are cut off, rather than towards their roots, and this is only perpetuating the evil which it was intended to remove. But even in this case, such a number of branches may be produced all along the stem, by interrupting the flow of the sap, as will soon make a thick and neat fence. For this purpose, incisions are made, at different places, into the bark, extending half way round the stem; and, the flow of the sap being thus interrupted in its progress, buds will soon appear and shoot forth, usually close under, but sometimes over the incision. This simple operation performed early in spring, by the hedge knife, or even by a pocket knife, does not seem, in the least degree, to injure the thorns; for the cut being clean and not deep, no canker ensues, and it soon closes up again. Indeed, in most cases, the stems are soon so completely healed, that nothing remains but a slight scar in the place. The object being merely to intercept the sap in its ascent, the wood need not be cut, and it is only necessary to remove the narrow belt of both barks; but care must be taken, that no shred of the inner bark remains uncut to continue the circulation. The partial interruption thus produced has not been found injurious to the stem, as it merely causes a lateral exertion, in the vessels containing the circulating fluid, to overcome the obstruction; and the sap thus accumulated gives rise to the new branches, so that the same stem may be cut at two or more places if necessary. By means of these slight incisions, and by occasionally cutting down such stems as project out of the line of the hedge, it may be thickened to any degree desired, and trained into a uniform breadth and thickness not attainable by any other method.

In whatever way the old hedge is cut down, the directions already given for the management of young hedges are to be strictly attended to. When the young shoots have made some progress, the side branches are to be trimmed, and the hedge put into a proper shape. The same precautions are also to be observed with regard to the upright shoots, none of which should be shortened until the hedge has attained the wished-for height.

The cutting and pruning of hedges should always be performed at a time when vegetation is comparatively inactive, as they are otherwise much injured from an effusion of their juices. Old hedges should be cut down in the winter season; but it is to be observed, that the operation should not be performed during a hard frost. The hedge should be cut down, when the field next the ditch is to be broken up from grass, as it will become a fence before the field is again brought under tillage. As the field behind the hedge will not likely be in the same part of the rotation as the other, it will be necessary to form a dead-fence of the cut thorns on the top of the bank. When the hedge to be cut down is strong, the dead-fence will not require all the thorns, and a part of them may be taken away for other purposes, or for a similar purpose in another place.

The utility of the fence will be in a great degree diminished, if due pains are not taken to preserve it from gaps. In planting young hedges, these are guarded against by selecting plants of a uniform size, all of which may be expected to make equal progress, and afterwards protecting any place that appears weakly or thin, from being broken through by cattle. When old hedges are to be cut down, it frequently happens that they contain a number of such openings, and the period of cutting them down presents a fit opportunity for remedying these defects.

When the spaces in the line of thorns to be filled up are small, one of the thorns on each side of the opening may be bent down, and entwined with that on the opposite side. When the thorns to be laid down are large, they may be cut half through, as they are then bent down with facility; and it may be necessary to fix them down with hooks, in the manner practised by gardeners for procuring layers from valuable plants. Some earth being laid over them, they will soon send up a number of branches, which will fill the interval of the gap, especially if the earth has been of good quality, and enriched by the application of manure. But when the blanks in the hedge are too large to be filled up in this manner, they may be planted with thorns, those selected for the purpose being of a considerable size. In filling up gaps in old hedges, it is necessary to observe that the materials used are to be placed directly in the line of the thorns, for when projecting on either side, they present an unsightly appearance. In all cases the spaces thus filled up require protection for a great length of time. The too common practice of filling up gaps and openings at the bottom of hedges with bramble, cannot be too severely censured, as it tends to perpetuate the evil by preventing the thorns from spreading in the direction of the open space, and filling it up. Such an absurd practice it would scarcely seem necessary to censure, in order to guard against its adoption; but that farmers are not generally aware of its pernicious effects, is evident from the fact that it is so often practised.

There is no plant with which we are acquainted that can at all bear a comparison with the hawthorn as a hedge plant; but it is attended with this disadvantage, that it cannot be grown successfully in elevated and exposed situations, and, in such situations, various other plants have been employed. A mixture of plants in the hedge cannot be recommended, as it gives a bad appearance to the fence, and it rarely happens that a soil will be found equally suited for the production of different plants.

The stone-wall, when properly constructed, forms a durable and efficient fence, and in certain situations is to be preferred to the live-fence. There are many situations in which hedge plants cannot be raised, and it appears to be a wise arrangement in the economy of nature, that the earth itself furnishes the most appropriate materials for the fencing of land in every situation. On elevated grounds much exposed to the vicissitudes of the weather, which would greatly retard the vegetation of arborescent plants, rocky materials generally abound for the construction of fences suited to the situation. The live-fence, however, is to be preferred in every situation in which it can be raised, both for appearance and shelter.

The stone-wall may either be formed of stones alone, or it may be built with stones imbedded in mortar to give it greater durability. Lime is too expensive an article to be used in field fencing generally, but in parts of the country where limestone is plenty, and lime of course of comparatively little value, the coping may be imbedded in lime, while the the rest of the wall may be built dry.

The materials used in the construction of this species of fence may be sandstone, whinstone, or any other stone easily procured and of sufficient durability. Even the loose stones taken from the land may be made to answer, but they are generally inferior to any other, for, being generally round in shape, they present so small and smooth a surface while in contact with each other, that they cannot long retain the position in which they have been placed without the aid of mortar. They may be used, however, with advantage as foundation stones; and as many such masses are found near the surface of the ground, in the act of clearing away the obstructions to its cultivation, they can be got rid of in the most economical manner by being thus usefully employed.

Much of the stability of any wall, of whatever material it may be built, will depend on the knowledge and dexterity of the builder. The best builder of a dry wall is he who practises no other kind of building than that of dry materials; for any ordinary mason, particularly in building rubble-work, depends so much on the mortar keeping the small stones safe inside of the wall, that he will not take the trouble to imbed them firmly.

In choosing the line of fence for the foundation of a wall, the ground should be as hard as possible to prevent it from sinking. A good foundation may be found either upon a natural sward, or upon removing the soil which has been disturbed by the plough. If the soil be deep in any part of the line, the arable or soft part alone may be thrown aside; or, if it is not very soft, the largest and flattest stones may be used as a foundation upon the surface of the ground. Over a slight depression of the ground, if of considerable extent, the top of the wall should run along a line of the same apparent elevation for the sake of its general uniform appearance. The line of the wall being fixed, a frame of the size of a section of the intended wall is to be placed on it in a perpendicular position by a plumb line, and to this the builder is to attach his line for the purpose of insuring straightness and regularity. The intervals between the large stones is to be filled up by the smaller ones, and it is desirable to place stones at intervals of sufficient length to cross the wall, to bind the other materials firmly together.

The wall is thus built up to the desired height when it is prepared for the coping, by laying thin stones on the top to make the building level. Different sorts of coping may be used, but that formed of stones is not only the most durable, but is also better in character with the entire fence. The stones for this purpose should be selected from the rest for their flatness, strength, and apparent durability. It is not necessary that all the covers should be of the same thickness, for the coping can be formed of lower stones under the thickest covers. These covering stones secure effectually the top of the wall, and prevent much of the rain, that, without them, would descend into the wall.

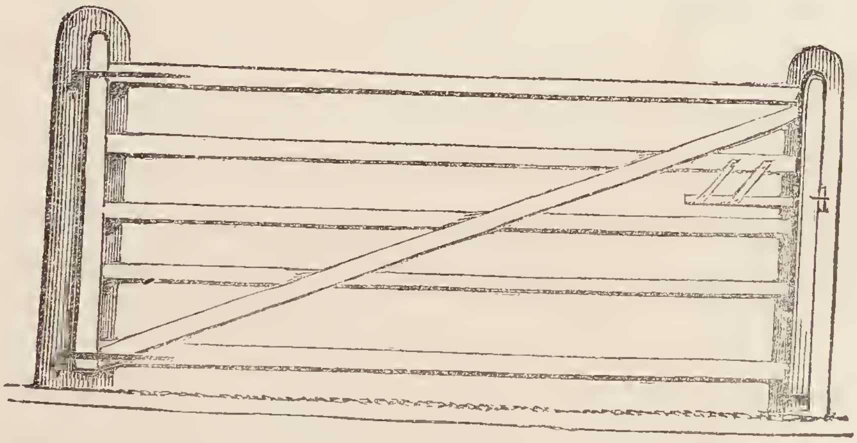
The dimensions of the stone wall to form an efficient fence may be 30 inches wide at the bottom, 16 inches wide at the top, and including the coping 4½ feet high.

The gate has been mentioned, as connected with the fence. It may be regarded as a moveable part of the fence, or as a frame of timber or iron readily moved, and calculated to give a convenient access to the enclosures. The properties of a good gate are, that it shall combine with lightness the necessary strength, so that an equal quantity of materials shall produce the strongest gate; and further, that to these properties shall be added durability. The absolute strength of materials depends on their hardness and tenacity. A gate, therefore, consisting of one solid plate of wood or iron, would seem to require most force to break or tear it in pieces; but this would not be consistent with lightness and economy, and, in the use of such a gate, it would be found to open and shut with greater difficulty than one less strong. The skeleton of a plate of wood or iron is therefore resorted to, by the employment of slips or bars, disposed and joined together on mechanical principles. These bars must be at such a distance from one another as to prevent the passage of animals, and so connected as to be firmly bound together.

The construction of the gate best adapted for opening and shutting is next to be considered. All gates, after being hung, have, from their gravitation, a tendency to deviate from their original position, to sink at the head or falling post, and thus no longer to open and shut freely. If the construction and hanging of the gate were perfect, this could not possibly take place; but as the least degree of laxity in the joining of the bars, or want of firmness in fixing the post in the ground, will occasion, after frequent use, a sensible depression at the head, it becomes requisite either to guard against it as much as possible in the first construction, or to make some provision for rectifying these defects as they take place.

In hanging the gate, the heel may rest in a socket placed in the ground, or it may be hung upon two hinges as represented in the figure. To obviate the tendency of the gate sinking in front from its own weight, the bars should taper towards that part, so as to be lightest there; and to prevent carts in passing through from tearing away the fastening of the latch, or injuring the hinges, the gate may be made to shut against the posts as in the figure. The contrivance for fastening the gate will be found at once simple and convenient. The piece of wood representing the latch is attached to the cross-bar by means of two pieces of hoop iron, which, from the way in which they are placed, have a tendency to force it out to the right hand,

Fig. 40.



and thus make it go into the fastening mortised into the front gate post.

The gate represented in the figure is seen to consist of five horizontal bars, and two upright bars, into which the extremities of the horizontal bars are mortised. The diagonal is joined to one side, and abutting on the upper bar, and on the other side may be fastened an upright brace. The length of the gate may be nine feet, the height over the horizontal bars four feet, the lower bar standing about six inches from the ground.

Gates are generally constructed of timber, and whatever kind may be used it is essential that it be well seasoned, as, without attention in this respect, they are soon deranged in their structure by the heat of the sun. Oak is undoubtedly the best sort of wood for the purpose, where durability is the object; but some of the lighter kinds of wood answer the purpose well, and are obtained at nearly half the expense. Excellent gates are formed of larch, and they combine cheapness with durability. Iron, both hammered and cast, has long been in use for ornamental gates, and has lately come into use for field gates in some districts. Their eligibility must depend on their price and durability with relation to wood, and, on comparison, they will be found to be of very doubtful economy.

The posts or pillars to which gates are attached should, in all convenient cases, be formed of granite, greenstone, or of any of the harder rocks, hewn to the proper size. When formed of wood, larch will answer the purpose well, but any coarse kind of timber of sufficient strength may be employed. They should be sunk to a good depth in the ground, and the part below the surface will be preserved from decay by being slightly charred, and by receiving a coating of oil, or pyroligneous liquor.

Neat and well-finished gates are a characteristic of good farming, and are considered essential in every well-cultivated district. To preserve them from decay, in addition to their being constructed in the best manner, they should be covered by two or three coats of oil paint. The effect which this preparation has, in defending wooden structures from the influence of the atmosphere, is well known.

VI.—PREPARATORY OPERATIONS OF TILLAGE.

I.—DRAINING.

Draining has already been mentioned as an important mean of increasing the productive powers of the soil. In many cases an excess of moisture is one of the main causes of infertility, and a primary purpose of the husbandman is, therefore, to remove it from the ground.

The successful practice of draining land depends, in a great measure, on a proper knowledge of the structure of the earth's upper crust, that is, of the various strata of which it is composed, as well as of their relative degrees of porosity, or capability of admitting or rejecting the passage of water through them; and, likewise, of the manner in which water is formed in, and conducted from, the hilly situations to the level grounds. It has been ascertained that the crust, or upper covering of the earth, is mostly composed of materials lying in stratified order, and in oblique or slanting directions. Some of these strata are capable of admitting water to pass through them, while others do not allow it any passage, but force it to run or filtrate along their surfaces, without penetrating them in any degree, and in that way conduct it to the level grounds. It there becomes obstructed in its passage by meeting with impervious materials by which it is forced to the surface, and soon renders the soil unfit for the purposes of agriculture.

When lands have a sufficient degree of elevation to admit of any excess of moisture to pass away, and when the materials of the soil are of such a uniform sandy, or gravelly, and uninterrupted texture as to allow water to pass through them with facility, they can be little inconvenienced by moisture coming upon or into them, as it must necessarily be soon conveyed into the most convenient outlets. But when they are in a great measure flat, and composed of materials which imbibe and retain moisture, they must be exposed to much injury from their retention of it.

To perform properly the operation of draining, attention should be paid not only to the discrimination of the differences in regard to the situation of the land, but also to the nature, distribution, and depth of the materials composing the soil and subsoil; as upon each of these some variety, in respect to the effects of water retained in them, and the means of its removal, may depend.

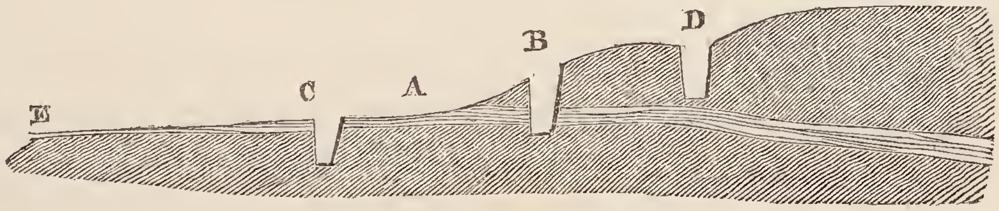
The subsoil is, in general, of a different structure from the upper soil. It may be composed chiefly of gravel or sand, or a mixture of both, which, being porous, and readily absorbing all excess of moisture, may not require draining. But in the case of clayey subsoils, which are impervious to moisture, the assistance of drains is necessary to carry off all excess of water retained in the soil.

Wetness in land will generally be found to proceed from one of the following causes, or from both combined. It may be caused by water collected and formed on the higher grounds, which filtering among some of the different beds of porous materials that lie immediately upon the pervious strata, forms springs below, and flows over the surface or stagnates beneath it; or, it may be caused by rain or other water being retained on the surface from the retentive nature of the soil, and the particular situation of the ground. The wetness which shows itself in different situations in the form of bogs, swamps, and morasses, for the most part proceeds from the first of these causes; but that superficial wetness which is so often seen in stiff tenacious soils with little inclination of surface, generally originates from the latter.

On an examination of the situation of the various earthy strata, they are found to be exceedingly irregular, having all degrees of inclination from the horizontal to the perpendicular, and being of all degrees of thickness, from a few inches to several feet. Their composition and texture are not less various from that of the most tenacious clays to the porous sands. The stratification will frequently be found to consist of alternate layers of retentive and porous substances, the latter affording moisture to pass through freely. When these strata are irregular the moisture of the soil is interrupted in its progress, and must then find its way into the next porous stratum, having a ready outlet; and when these obstructions to the course of water in the soil exist near the surface of the ground, the water makes its appearance there, and the object of the drain is to ascertain the easiest and most effectual plan for its removal.

The soils which suffer most from superfluous moisture are the different kinds of clay which are situated on retentive subsoils. When they are arranged in regular undulating beds of different lengths, and separated by occasional beds of sand, these undulations act as basins in intercepting and collecting the water which permeates gradually through the detached lines of sand. This permeant property permits them to contain great quantities of water, and accordingly, we generally find this kind of land very wet, and difficult to manage before it is drained. Very often a thicker bed of sand than the rest divides the mixed clayey subsoils from clay of a different and generally more homogeneous structure below it; and in cases where this homogeneous clay is not more than four or five feet below the surface, which is generally the depth at which it makes its appearance, it will be proper to construct a leading or main drain through the sand to that clay, that it may form the bottom of the drain. When any bed or stratum of this kind is not of uniform depth, and situated on the side of declivity of a greater or less degree of elevation, the stratum of sand frequently crops out at the surface. In this case the water will flow out at the termination of the bed of sand, and form a burst or spring, oozing over and saturating the ground, as in the figure, in which the water in seen coming out at A and overflowing the surface from A to E.

Fig. 41.



In this case the object is to intercept the course of the water before it shall reach the surface, and thus remove the cause of wetness. This is effected by cutting a drain at B; should the drain be formed at C, it would fail to interrupt the water, and should it be made at D, it would be equally inoperative. In the former case it is made too low, and when filled with earth, the water would run over the drain; and in the latter case it is too high, the conducting stratum being at such a depth as not to be reached by an ordinary drain.

In ascertaining the proper situation of the drains there, the line where the wetness begins, which is generally rendered perceptible by a change of colour in the soil, the tendency to produce subaquatic plants, and other indications of wetness, mark, for the most part, the course which the line of the drain should follow. By cutting a drain nearly in this line, sufficiently deep to reach the porous stratum in which the water percolates, it shall intercept it before it reaches the surface, and by carrying it away in some convenient outlet, remove the cause of wetness. The line of the drain is drawn nearly at, or a little above, the line of wetness.

This species of draining is not attended with any difficulty. The direction and situation of the drain are ascertained at once, and the water thus intercepted is to be conveyed away into the nearest convenient outlet. But, as water may arrive at the surface in different ways, and the wetness be produced by different causes, so variations from this rule of lining out the drain may be required, and the judgment of the drainer is to be shown in adapting the course of his drain to the change of circumstances.

When the soil and subsoil are of a mixed nature, the most prevailing parts of the clayey kind, the process of draining is considerably more tedious and difficult than when the superficial and subjacent strata are disposed with greater regularity. In such lands, the collections of water are commonly separated from each other by the intervening beds of clay, and they become so much increased in time of heavy rains, as to flow over these obstructions, and rise to the level of the surrounding surface. The water, thus finding a free passage, as it would over the edges of a bowl, overflows and saturates the ground, rendering it so wet and sour, that its produce becomes annually more scanty, and the soil itself more sterile and unproductive.

From the porous beds, in the case of these mixed soils, frequently having no connexion with each other, it will require as many deep drains as there are beds of this kind, in order fully to draw off the water from each of them. A drain is, therefore, to be cut down from the lowest part of the field intended to be drained, up to the most elevated bed of porous materials, in such a line of direction as, if possible, to pass through some of the intermediate ones, and thus prevent the labour and expense of making larger cuts on the sides, which would otherwise be requisite.

In the case of mixed soils, indeed, no rule is strictly applicable in all cases; the drainer must, therefore, adapt his remedy as much as possible to the cause of injury. One end, however, to be aimed at in all cases, is to reach the bed, channel, or reservoir, in which the water is retained.

In flat grounds, a drain carried through the hollowest part of them will act as a desiccative to the soil for a considerable distance on each side of it; because, in such hollows, the soil is generally deep, and occupies a basin-shaped cavity, formed by the retentive subsoil, which supplies the water to the soil as a sponge. If the drain be carried to such a depth, that its bottom may be formed in the retentive subsoil, the water which has been retained in the latter will be carried away through the former. When a flat piece of ground is situated on the top of a bank, either level or a little inclined towards the bank, which it will most likely be, a drain through the hollow of the flat will take away the burst of water near the top of the slope; because, when the water accumulates in the subsoil, upon which the flat ground rests, it will overflow its edge in wet weather, and, running down, by the force of gravity, on the face of the bank between the soil and subsoil, it will come through the former to the surface.

The cases of wetness in land which have been mentioned are those chiefly proceeding from subterraneous water arriving at the surface through the medium of fissures or openings; and, for the removal of these, the larger class of drains is required. It will be perceived, that the depth must be regulated by that of the porous stratum which is to be reached, and will vary from three to four feet, and sometimes more. Before beginning to open these drains, it is generally advisable to ascertain the nature of the substances to be digged through in the execution of the work.

In making these pits, the materials excavated are to be placed at such a distance from the opening on the lower side of it, as not again to fall back or press in the sides. These are to be sunk down to the porous stratum, but should no water be found after sinking a considerable depth, the boring rod is to be applied to ascertain at what depth it may be reached. Cases may occur in which water cannot be reached even with the auger, and in this case the previous examination thus made will save further trouble. Such preparatory examination is also useful in enabling the drainer to form an estimate of the probable expense of the execution of the work.

The superficial wetness of lands is seen to proceed from causes different from those by which springs are produced, and a different plan of proceeding must be adopted, in this case, to carry off the water.

It is well known, that the land rendered wet by water springing from below, bears a very small proportion to that injured by the retention of the water that falls upon the surface in the state of rain; and that, even in those soils which are usually considered dry, the tardy and imperfect escape of the rain water renders their cultivation, in many cases, difficult and precarious. Their fertility also, from the same cause, is often below what would uniformly exist under a state of thorough dryness. This is experienced in a greater or less degree as the subsoil is retentive or porous.

When the active soil is incumbent upon deep beds of sand or gravel, the water that falls upon the surface is instantly absorbed. On the contrary, when incumbent on massive beds of impervious till, the water must run slowly off over the surface, saturating in its course every particle of the ground with moisture; or in the event of a horizontal or hollow surface, remain stagnant until evaporated by the sun, or absorbed by the atmosphere. Some soils, again, rest upon subsoils partially pervious to moisture. These, by judicious management in favourable seasons, produce good crops; but when much rain prevails, they are neither bulky nor of good quality. Lastly, where there is a sufficient body of active soil incumbent upon a rock, which is open from its numerous fissures, the land is uniformly fertile.

If, then, we observe the operations of nature, we shall be at no loss for principles to guide us in the drainage of soils rendered wet by surface water. In the last-mentioned example, the open rock under the soil affords frequent and pretty uniform channels of escape for the water; and hence the obvious suggestion of the frequent-drain system, which, by effecting a complete and uniform dryness, produces results perfectly analogous to those of nature.

When drains, placed near each other, have been executed some time, innumerable small fissures will be found in the subsoil, extending from drain to drain. These are caused by the contraction of the substance composing it, arising from its drier state, and they generally reach to the level of the bottom of the drains. They will, no doubt, be more or less glutted up, from time to time, by the minute alluvial particles carried down, and left in filtration by the rain water ; but the constant contraction and expansion of the unmoved subsoil by the alternations of moisture and drought, have a perpetual tendency to remove them, so that, as long as the drains flow freely, there will never be wanting minute channels for the percolation of the water from all parts towards the drains.

It is evident, however, that this property of the soil cannot be evolved to the necessary extent, unless the drains be placed so close to each other as to effect a thorough and speedy absorption of the superfluous moisture retained between them ; for the lower strata are so withdrawn from the direct influence of the sun and atmosphere, that no considerable portion of the moisture retained by them could escape without the intervention of numerous artificial openings, and, therefore, the natural fissures consequent on their action could not be produced. To drain adhesive soils thoroughly, a great number of drains are necessary; and they must be disposed in such a way as to collect and convey the water every where from the surface. When there happens to be hollows or irregularities in the surface of the land, water may often be observed to continue standing in them at a distance of but a few feet from the drains.

The chief object in view in this species of drainage being the removal of surface water, the term *surface-draining* has been applied to it. From the drains sometimes being placed in the furrows of the field, it has also been called *furrow-draining ;* and from the drains occurring at frequent intervals, it has been designated *the frequent-drain system.*

This system was originally employed in draining the heavy clays of Essex, and was, for a length of time, confined to that county. It has now gradually extended itself over all the heavy soils in England and Scotland, and has been practised to a limited extent in several districts in this country. Though expensive, it is efficient and easily practised, and produces an immediate effect on the land. It may be advantageously combined with the system of deeper drains, the latter being employed to intercept the springs and larger body of water, and the former to give an increased degree of dryness to the surface.

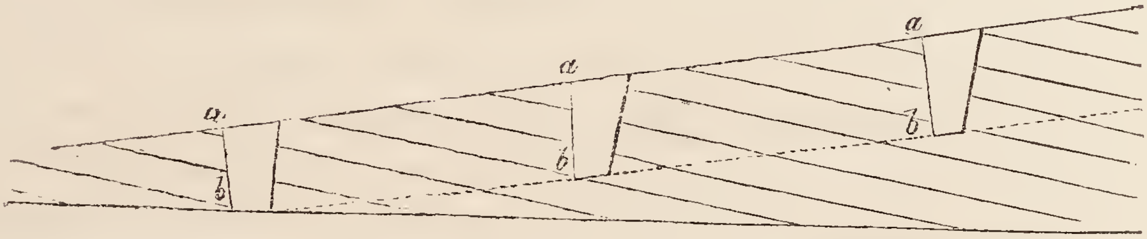
The principle adopted in laying out this class of drains is to form one or more main or receiving drains across the ground to be drained, and to conduct into them the minor drains, which follow the direction of the ridges. The larger drains receive the water from the smaller drains, and they should always be cut deeper than those coming into them, that the water may have a free drop, which will prevent the lodging of sand or mud about the junction of the drains. Open cuts or ditches should never, except from necessity, be adopted, as they are apt to get filled with mud and grass, by which water is thrown back into the smaller drains, which often chokes them; besides, the loss of land, annoyance in ploughing, constant expense of cleaning, and unsightly appearance, are serious objections.

The main drain being made, matters are prepared for setting off and extending the smaller drains through the field. They may be executed at any season when the weather will permit. It is better to execute the draining when the fields are in grass, just before being brought under tillage, as in this case, the work can be done in all sorts of weather in a more cleanly manner.

In laying off the drains, the first object for consideration is the nature of the subsoil. If it consists of a strong till, the distance from drain to drain may be from twelve to eighteen feet; if a lighter and more porous subsoil, a distance from eighteen to thirty feet will be close enough; and in more open subsoils, they may be placed a still greater distance asunder. They are laid off in parallel lines, usually in the direction of the ridges of the field. The longitudinal direction is, in all cases, to be preferred, as the chances of the drains being choked up by depositions of mud or other alluvial matter are thereby diminished; and, in the event of a drain being stopped, the water will, either by its altitudinal pressure, force through the obstruction, or, by bursting out at the surface, will show very nearly the spot where the evil exists.

It is, however, a very general opinion, that drains laid off in this manner will not be so effectual in drying the land as when placed across the ascent; but it is believed, that this opinion can be shown to be erroneous. Drains drawn across a steep, cut the strata or layers of subsoil transversely; and, as the stratification generally lies in sheets, at an angle to the surface, it will be seen, by referring to the annexed figure, that the water passing in or between the strata, immediately below the bottom of one drain, may come to the surface before reaching the next lower drain, as at *a a a*. But, as water tends to the lowest level in all directions, if the stratabe cut longitudinally, by a drain passing down the acclivity, the bottom of which cuts each stratum to the same distance from the surface, as represented by the line *b b b*, the water will flow into the drain at the intersecting point of each sheet or layer, on a level with the bottom of the drain, leaving one uniform depth of dry soil.*

Fig. 42.



It is of importance to be accurate in laying off the drains as described, as it secures uniformity of dryness, and, in all future operations, or at any time, it is easy to ascertain the line of any drain. It may prove of use in after times, to have a plan of each field, with the lining of the parallel drains and main drains accurately laid down, and the lengths and distances marked in figures, to remain as a reference.

Having considered the causes from which wetness in land proceeds, with the description and arrangement of drains best calculated for removing it, it now remains to point out the proper size of such drains, and the manner in which they are to be executed.

The most general plan of performing this sort of work is to pay the workmen a stipulated sum per perch, or score of perches. In this case, the work should be frequently inspected from time to time, to see that it is performed to the proper and required depth, that the earth taken out is laid in such a manner as not to fall down again into the drain, and that the surface mould is kept on one side, apart from the materials composing the inferior stratum.

The dimensions of drains must depend on the nature of the soil, the position of the land, and a great variety of other circumstances.

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* Smith on Thorough Draining, &c.

The width of the drain at the top is regulated by its depth, it being usual, except in the case of very hard and tenacious substances, to make the sides of the drain slope from the top to the bottom, to prevent the earth from falling in after it has been opened to the necessary depth. In the frequent-drain system, the drains are of a more uniform depth than when the object is to intercept the course of springs. In the latter case, they must be of a sufficient depth to reach the water. It is not, however, necessary that the drain should be of this depth throughout, for if the spring be opened at any particular place, and a sufficient aperture made for the water to flow into the drain, the object in view will be accomplished.

As the work proceeds, it is, therefore, advisable to form pits or holes at intervals along the course of the drain, by which the water will be allowed to flow up from below into the cavity of the drain, and, in this manner, the labour of sinking the drain to a great depth is avoided. The application of this principle had been familiar from the remotest times in the sinking of wells; but it was not till after the middle of the last century that the same principle was applied to the drainage of land. This was done by Mr. Elkington, a farmer and drainer in Warwickshire, from whom that system of drainage derived its name.*

In all cases where the water to be reached is at some depth, the drains should be made of sufficient dimensions to effect the purpose. They should rarely be less than from three to four feet deep, even where the pervious strata lie at less depth, for the purpose of permanence and greater security. They, must, however, be carried through the impervious stratum immediately above the water, should this be five, six, or even seven feet below the surface, though the expense and difficulty of executing the work increase in a great proportion as the dimensions of the drains increase.

Drains intended to carry off surface water need not be more than from twenty-six to thirty inches deep, which admits of a sufficient depth over the stones or other materials used in filling, to guard against injury from the treading of the working cattle in the cultivation of the land.

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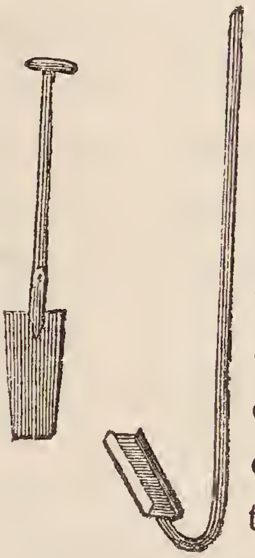
* A full exposition of the principles upon which Elkington proceeded, and the practice he adopted, will be found in Johnston's Treatise on Draining and Embanking.—Edinburgh, 1834.

The situation of the drains being ascertained, the position of each is marked out by a line and pins placed along it, or, in the case of the smaller drains, by the plough. In the latter case, it has been said, the drains are usually placed in the furrows of the field, and the plough passing up and down each furrow and paring off a slice from each side, as deep as convenient, abridges the labour in opening the drain in a material degree. It is hardly necessary to mention that the drains are, in every case, commenced at the lower end, and carried up the acclivity. The drain is seldom formed to the required depth at a single operation, the more usual way being to sink a few perches or rods a spading or two in depth, and then going over it again, and so on to the bottom. Should the drain become so much diminished in width as not to admit the common spade and shovel, a narrower spade, *Fig.* 43, is to used, and a scoop, *Fig.* 44, for taking out the loose earthy matters. The bottom of the drain should be cut as straight and uniform as possible, so that the water may flow freely along at all places; and it is better to cut a little deeper where there is any sudden elevation of the surface, than to follow it, even should it still possess a certain degree of inclination to carry off the water; and where sudden hollows occur, the cutting may, on the same principle, be less deep. Attention to this admits of after-straightening or levelling the surface of the land, without any injury to the drains.

Figs. 43, 44.



The materials used in filling drains are numerous. Where stones can be procured, they are invariably employed, and in their absence tiles, furze, or bramble of any description.

Where the stones are small, they may be thrown promiscuously into the drain, and there will be a sufficient passage through them for the water to run, unless the quantity is great. In the latter case an opening is made by placing the larger stones in such a manner as to form a hollow triangle, having the bottom of the drain for its base. The smaller stones are carefully placed by the hand on each side of those forming the sides of the triangle, until a level surface is formed, after which the remainder of the stones is thrown promiscuously in. When the bottom of the drain is soft, it is frequently found necessary to place a row of flat stones along it before placing the others. These serve as a base for the upright stones, and also prevent the earthy materials from collecting in such quantities as to stop up the course of the drain.

The size of the stones used in filling will depend on that of the drains. They may be used of considerable dimensions in the larger class of drains without any impropriety, but in those of the opposite description they must be broken small, otherwise they are liable to choke up the course of the drain. The stones are laid down on the upper side of the drain, and the earth taken out of it on the lower. It is very desirable that the stones should be, if possible, laid down before the drain is commenced, as it is often necessary to fill it up again as fast as it is formed, to prevent the sides from falling in, which, when it occurs, occasions a great deal of extra work. This most frequently happens in ground under tillage, the soil being then much less adhesive than when in grass. Circumstances sometimes occur which prevent the stones from being laid down beforehand, and they are often brought forward while the work is going on. Under the eye of an attentive and intelligent director, this may be done without danger; but, even then, unforeseen occurrences sometimes prevent the possibility of getting the materials forward for several days.

The stones may either be laid down at intervals by the sides of the drains, to be there broken, or being broken in masses in some convenient spot, and at such convenient seasons as best suit for the employment of spare labour, they can be brought by the carts ready to be filled in. No stones thould be filled in until the whole line of drain has been cut out and inspected; but the sooner drains are completed after being cut the better, and they should always be filled from the higher level downwards. Sometimes, where there is much tendency of the sides to fall in, it becomes necessary to fill in going along. Cutting in the summer, when there is little water in the soil, or in any dry season, saves much of this. In soft or sandy bottoms, by cutting the drains to half the depth in the first instance, and allowing them to remain so until the water has been voided from the upper stratum of the soil, the lower part may then be cut out with less danger of falling in as the work is executed.

Tiles are used in filling drains when stones cannot be procured, which is sometimes the case in flat and clayey districts. They are employed with greatest advantage in the smaller class of drains. Where tiles are used, it is seldom necessary to make the drains as deep as where they are to be filled with stones; for if placed at a great depth from the surface, and not covered with any more porous material than the soil itself, the surface water finds its way into tiled drains with difficulty. The drain is also carried down as narrow as it can be formed, the excavation at the bottom being of nearly the same dimensions as the tiles. The tile usually consists of a semicircular piece of earth, manufactured in the same manner as bricks, of about fourteen inches in length, and perforated with holes to admit the water to pass through from the soil to the conduit formed for its reception. Flat soles are made of the same material, on which the arched tiles are to rest, to prevent the loose matter of the soil from filling up the opening.

The other materials for forming a passage for the water in the drains, are bramble, furze, gravel, or any other porous substances. They are all more or less temporary, according to the particular substance employed, and should never be used if either stones or tiles can be procured. Various other modes have been recommended of filling drains, and local names given to each of them; but, in a work like the present, they are undeserving of notice, as they can seldom be recommended to the practical farmer.

After the conduit or passage is formed, or the first course of smaller stones placed in the bottom, as the case may be, the drains are to be filled still further with small stones or other porous materials to within fifteen inches of the surface of the ground. The upper surface of the stones having been made straight and uniform, the whole should be neatly and closely covered with turf cut from the adjoining surface, or brought from some suitable place. Strict attention to the execution of this operation is of the first importance, as the passage of the water in the drain may be impeded or altogether stopped by particles of loose earth going down among the stones. When the land is under tillage, and turf cannot be procured in an adjacent situation, some other materials must be employed, such as straw or rushes. The earth which was taken from the surface of the drain is now placed over the stones, and the more impervious substances taken from the bottom of the drain are to be shovelled in as the filling advances, until the top of the drain is somewhat higher than the surrounding surface. The purpose of thus raising it is to provide for the subsidence of the loose earth, which will afterwards become more compact, and occupy a smaller space. Where the surface of the stones has been carefully covered, so as to prevent the admission of the loose particles of earth among them, the plough may be used for filling in the remainder of the drain.

When the drain is thus completed it is still necessary, and particularly where the land is under tillage, carefully to inspect it from time to time, and to see that no surface water finds its way into it by any direct communication. If any hole be found, it ought to be immediately stopped up, as a channel of this kind will sometimes carry enough of mud into a drain to choke it entirely, and prevent the course of the water. Water from the surface should find its way into the drains by gradual percolation through the covering placed over them, instead of by any direct channel.

Draining has occupied much of the attention of farmers for some time past, and in the more improved districts no other branch of husbandry has attained to greater perfection. It is indeed at the foundation of all other improvements in land, and must take precedence of them all. The practice of the frequent-drain system appears to be one of the most important improvements in modern agriculture, and, when combined with deep pulverization, enables the farmer to impart such a degree of fertility to the soil as he was hitherto incapable of producing.

The thorough drainage of lands suffering from excess of moisture is indispensable, before that degree of pulverization can be produced, which is essential to fertility. It was the want of thorough drainage which formerly rendered deep working, or trench ploughing, a hazardous and dangerous operation, especially on heavy lands with a close subsoil. The fertility of the soil is known to depend in a great degree on the facility with which a due degree of pulverization can be maintained, and this quality in its turn is influenced by the relative proportions of the different ingredients, and their capability of retaining or freely parting with moisture.

The precise proportion of the substances most conducive to fertility in the soil is rarely found to exist in nature. Indeed the soil of many districts consists almost wholly of clay, and consequently their cultivation has hitherto been rendered a matter of extreme uncertainty, from the mechanical arrangement being so liable to be disorganized by an excess of either wet or drought, the pulverization in either case being completely destroyed. The property which all soils inherently possess of alternate expansion and contraction, according to their comparative state of wetness or dryness, is also of service, to explain the theory of pulverization. Were it not for this property it would be altogether impossible to prepare our heavy clay soils for the reception of the seed. Fallows no doubt are of use, but they are only advantageous in virtue of it. In a favourable season, for example, with alternations of sunshine and moderate showers, clay fallows can be reduced to a very fine state of pulverization, this power of contraction and expansion being then in active operation ; but in extreme wet or dry seasons, pulverization does not take place, and the summer-fallow is in either of these cases of little advantage, a casualty which is of frequent occurrence in our variable climate. Until lately, however, the fallow was the acknowledged mean of restoring the fertility of soils exhausted by over cropping or other mismanagement, but this expensive operation is now superseded in a great degree by thorough drainage and deep working afterwards during the winter, by which the required depth of soil is obtained without interfering with the cropping of the land.

It must be observed, however, that the system of thorough drainage, however perfect, is not rendered complete, until the operation of subsoil ploughing is accomplished. Many farmers consider they have completed their task, when the drainage is performed to their satisfaction, whereas it is merely a part of the system, and only a means towards an end, and subsoil-ploughing will in most instances be found indispensable to its perfect completion.

When rain water falls upon the surface of the land, all that is superfluous naturally sinks to the bottom of the furrow; or, in other words, to the subsoil, and if the latter is retentive, the water will naturally there remain stagnant. Hence the necessity of stirring the subsoil to prevent the water from meeting any obstruction, until it arrives at what may be denominated the second surface, whence it will percolate, seeking the lowest level, until it reaches the drains. The fissures in the soil consequent on thorough drainage, may in many cases convey the water with facility to the drains, yet it will be only under very peculiar circumstances that this necessary operation of subsoil-ploughing can be dispensed with ; besides it is trusting to an uncertainty which may cause much disappointment and loss, for in retentive soils the lower strata are so far removed from, and impervious to, the action of the atmosphere, that unless these fissures are superinduced by the aid of the subsoil plough, a considerable time may elapse before they naturally take place. It is, however, to be regretted, that a large proportion of the drains, on the frequent-drain principle, will not admit of this operation on account of being filled to within ten or twelve inches of the surface with stones. Many intelligent farmers fill their drains on this principle ; but it must be admitted that they have formed a very erroneous estimate of the importance of deep working, and have thus deprived themselves of the advantages to be derived from its adoption. It is now, in fact, well established that thorough draining of itself, however beneficial, is not more important than deep working, and it is only by adopting the former, that we are enabled to execute the latter operation with safety. It is, indeed, from the combined effects of draining and deep working, that the greatest improvement may be expected, and when this is accomplished in a proper manner, no definite limits can be assigned to the productive powers of the soil.*

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* " In using the subsoil plough it is necessary to proceed with caution, and perform the operation judiciously. Many individuals subsoil their ground when it is in a soft pliant condition, so that in place of breaking the soil in pieces, the plough is merely dragged through it; and this injudicious use of the subsoil plough has tended very materially to prejudice the minds of many agriculturists against it. We would therefore recommend all those who intend using the subsoil plough to examine minutely into the state of their subsoil before commencing operations, and upon no account to persevere unless there is prospect of the plough leaving in its course openings for the escape of the water, for they may rest assured that the desired amelioration can be only obtained by a judicious application of the instrument. It may also be remarked that much misconception prevails with respect to subsoil and trench ploughing ; these two operations being often confounded together without making any distinction between them, whereas no two operations are more distinct or more different in their immediate results. In confirmation of this opinion we have only to refer to the practice and experience of Mr. Smith. That gentleman being well aware of the compact nature of the subsoil on Deanston farm, was led to devise some means whereby he might be enabled to break it up or stir it, so that the water might readily descend and make its way towards the drains. The principal obstacle which pre-

II.—REMOVING OBSTACLES TO TILLAGE.

The most frequent impediments to the common operations of tillage are those arising from an excess of moisture, from the roots of

sented itself against the accomplishment of this object was the barren nature and general poverty of the subsoil. Mr. Smith was aware that he could not bring this to the surface with the trench plough without endangering the fertility of the whole mass for perhaps many years to come, and hence the idea of subsoil-ploughing first occurred to him, by which means the lower stratum would be stirred without bringing as much to the surface as could in any shape endanger the fertility of the active soil. He thus attained the end he had in view. The atmospheric air was enabled to act freely on the subsoil, and the rain water, passing through the surface soil, carried along with it a certain portion of enriching matter, which was imparted to the barren under-soil. He was thus enabled gradually to extend the depth of his active soil from a few inches to a depth of fourteen or fifteen, and what was formerly barren subsoil now constitutes three-fifths of the active soil on Deanston farm. It would therefore appear that those who make an outcry against the system as bringing up a pernicious subsoil to the surface, are not aware that the subsoil plough was invented purely to prevent such an occurrence, and that Mr. Smith did not use the trench plough, or increase his depth of active soil until he was convinced that he could do so with safety.

"When increasing the depth of the plough furrow, or active soil, therefore, much care and judgment are required to prevent such a quantity of the subsoil being brought to the surface as will in any way endanger the fertility of the whole. Subsoils, for instance, that have a considerable portion of sand or gravel in their composition may be deepened more expeditiously than clay soils, and it would perhaps be advisable, especially where strong clay or till prevails, not to exceed in depth above half an inch or so at each ploughing, until the desired depth is obtained, say from ten to twelve inches.

"Much, however, will depend upon the composition of the soil, the situation, and the state of the weather when the operation is performed, and upon the quantity of manure which the farmer may have at his command, for it is natural to suppose that the active soil will be in some degree deteriorated by bringing up a quantity of poor subsoil, and will therefore require a greater supply of manure in the first instance than otherwise;—but however abundant the application of vegetable or animal manure, lime is no less necessary in the majority of cases for the purpose of correcting any acidity which that portion of the subsoil may have imparted to the former active soil. We have stated ten or twelve inches as being all that is required for the active furrow, but we believe that if sufficient trees, and shrubs, from stones both on the surface and throughout the depth of the soil, from certain shrubs and plants spreading over

manure could be obtained, and the mechanical arrangement of the soil were such as to admit of a free circulation of the atmospheric air, that the productive powers of every soil, excepting pure sand, would be increased by stirring it to a much greater depth. It would at all events be advisable after the lapse of a few years, when the land has been thoroughly drained and subsoiled in the manner described, to have it trench-ploughed to the depth of fourteen or sixteen inches, and this operation should be regularly performed afterwards at intervals, but if the subsoil is constituted wholly of till or clay, we would certainly recommend more caution, and rather prefer subsoiling, more especially if manure is not at command; indeed if an extra supply of manure cannot be procured, subsoiling should always be preferred to trench-ploughing. The importance of deep cultivation will be more apparent if we consider the nature and habits of plants. Wheat, for instance, and almost every kind of vegetable will strike their fibres in search of nourishment to such a depth, that it is difficult to determine how far they will penetrate when not opposed by any impenetrable or pernicious quality in the under-soil. That sickening or exhausted effect produced by a too frequent repetition of the same kind of crop, will also be diminished, for whether this arises from some element in the soil necessary to the growth of the plant being exhausted, or, as has been supposed, from the excrement or some pernicious substance which is produced by the plants themselves, the deepening of the soil will in either case counteract, to a certain extent, the bad effects produced by a too frequent repetition of the same kind of crop; and this will be more apparent according to the depth operated upon. In accordance with the foregoing observations on deep ploughing, the propriety of proceeding with this operation early, or immediately after harvest, will be apparent, so that the soil intended for spring culture may receive the benefit of those alternate changes in the weather, which are so necessary to its perfect pulverization; for in this case the application of a grubber in the spring will be found an excellent substitute for the plough, and all that is necessary for preparing the ground to receive the seed. This stirring of the ground, instead of ploughing, possesses many advantages; as we not only dispense with a very precarious operation on clay soils when the spring proves wet, but we also preserve that nice mechanical arrangement which has been produced by the alternate frosts and thaws throughout the winter, and, what is no less valuable, the exposure of newly ploughed land in a dry spring is completely avoided. We are aware, indeed, that it was impossible before the system of thorough drainage was introduced, to maintain, for any length of time at least, clay soils in a fine state of pulverization, from the circumstances of the rain water not escaping readily, owing to the retentive nature of the subsoil. In consequence of this peculiarity, the more finely clay soils were pulverized, the

the ground, and from irregularities in the surface of the land. The first of these is necessarily a branch of draining; which has already been treated of at length.

Large tracts of land throughout the country, which might be advantageously brought under cultivation, are partially covered with shrubs and the roots of trees. Land situated in this manner is generally fertile, having been enriched by the large quantity of leaves and other vegetable remains which, in the course of ages, has fallen and rotted on the surface. Such are the beneficial effects of this process as a mean of increasing the fertility of the soil, that lands reclaimed, which had previously been woodland, have often been kept in the production of grain crops for a number of seasons without any addition of manure; but this management it calculated speedily to exhaust them. The obvious improvement in this case is to cut down the remains of any part of the stems of the trees or shrubs, and the roots are generally eradicated by trenching the ground. In grubbing up bushes and furze, care must be taken not to place the surface soil under the subsoil which is newly turned up, otherwise the land will be unproductive and sterile for a great length of time. It is, indeed, evident that a mixture of the soil and subsoil is of less importance in this case, than in land under continued cultivation.

more readily did they run together into a compact body: hence the origin of clods or compact pieces of soil being formed, which were however in their turn necessary for preserving a certain openness in undrained land; but had such land been thoroughly drained, these clods might have been wholly dispensed with, and the matter contained in them rendered subservient to the advancement of vegetation; for it must be obvious that land will possess the power of productiveness to a much greater degree when a fine pulverization can be maintained throughout all its parts, than when a considerable portion of what should really constitute the active soil, is lying as it were in a state of inactivity in the shape of clods. Indeed every practical agriculturist must be aware that land resting upon a retentive subsoil becomes often consolidated to such an extent, from the action of the winter's snow and rain, that frequent ploughings are necessary to bring it to a proper state of culture; not only so, but should the spring prove moderately wet, instead of the frost proving beneficial, the whole is often converted into one compact unmanageable mass, so that not unfrequently all attempts are in vain to prepare such lands for green crop, until the proper season is past."—*Mark Lane Express.*

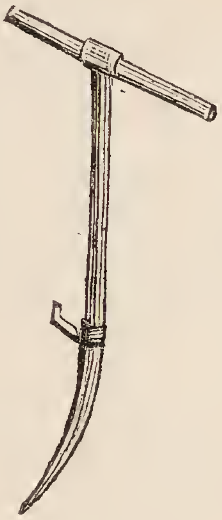
When any considerable portion of the subsoil is brought to the surface by trenching, or other means, a large supply of lime and organic manures is necessary to fit it for the growth of plants.

On the lighter class of soils, and in dry situations, the furze and broom frequently prevail to a great extent, and unless their progress is impeded, they continue to spread and overrun the surface of the surrounding grounds. They are got rid of in the manner already mentioned. It requires constant attention, however, to prevent such plants from again getting possession of the ground when restored to pasture. This is best effected by ploughing up the land occasionally, and cultivating potatoes, turnips, or other fallow crops. In moist weather, also, the young plants may be pulled up and destroyed.

Another and frequent impediment to tillage is stones. Those which impede the improvement of land are either loose, being brought to the surface when the land is trenched or ploughed; or fixed in the earth, and not to be moved without the application of a considerable mechanical force. Loose stones may often be converted into use for the purpose of filling drains, of constructing walls or fences, or of making or repairing the roads of the farm, or those in the neighbourhood. They may be removed with least inconvenience when the land is in fallow.

When the stones are large, or land-fast, the removal of them is a work of great labour. Those which appear above the surface are to be removed before the operations of tillage commence; and the locality of those which are covered by the soil, but not to such a depth as to be out of the reach of the plough, is ascertained by a pointed instrument which is repeatedly thrust into the ground to the depth of ten or twelve inches. Any stones with which the plough comes in contact, in the operation of ploughing, are marked by the ploughman with branches or pieces of bramble, a quantity of which he carries with him in the plough for that purpose. When the plough touches a stone in its progress, a branch is placed there, and this serves as a guide for the persons who follow to raise the stones. They are afterwards removed by first clearing the earth off them, and then applying the crow-bar on the principle of the lever. A useful instrument in this case is the foot-pick, *Fig.* 45, which is used with greater facility than the crow-bar, and, when the stone to be removed is small, it may be used with effect in raising the stone without the labour of removing the soil above it. The situation of the stone being ascertained by it, the instrument is then forced into the ground by the hands, assisted by the foot if necessary, and the stone in this manner raised. The tread is so placed that it can be removed to either side, as may be convenient for the workman.

Fig. 45.



There are various modes of getting rid of stones. Those raised in this way are generally of such a size as to admit of being conveyed away in carts, or other vehicles calculated for the purpose. In certain cases, pits are dug close to large stones, into which they are turned, and placed at such a depth as to lie out of the way of the plough. This, however, is a somewhat laborious operation.

Stones may be reduced in size by repeated strokes of a sledge; but when they are large, and of a close texture, it may be necessary to blast them with gunpowder. The method of bursting or rending rocks or stones by the action of gunpowder is a simple, though dangerous operation. When a hole is to be made in a rock, for the purpose of blasting, the nature of the rock, and the inclination or dip of the strata, if it is not a detached fragment, must be considered; as it is from these that the calibre, depth, and direction of the bore, or recipient for the gunpowder, are determined. According to circumstances the hole varies from half an inch to two inches in diameter; the depth, from a few inches to as many feet; and the direction varies to all the angles from the vertical to the horizontal. The implements for the performance of the operation are rude, and so extremely simple and familiar to every workman as hardly to require description; and the whole operation of boring and blasting rocks is so easily performed, that, in the space of a few weeks, any intelligent labourer may become an expert quarryman.

The removal of stones of all descriptions is an important preparatory operation in the cultivation of land. The soil round a large stone is in general the best in the field. In stony land the plough must proceed slowly, and cannot perform half so much work as it ought to do; but after such impediments have been removed, the field may be ploughed with the usual facility, and in a much more perfect manner.

When land has remained for some time in grass, certain plants occasionally make their appearance, and must be regarded as obstructions to tillage. Such are the fern and heath. The former is a very troublesome plant to extirpate, when it has obtained possession of the soil, as in many cases it sends down its roots into the under stratum, beyond the reach of the deepest ploughing; but it is a criterion of fertility in the soil when it grows to a large size. It should be frequently cut over during the summer when it is green and succulent, but after every exertion it will sometimes make its appearance again at an interval of several years.

When heath appears, it indicates a certain proportion of peat in the composition of the soil. Though much less difficult to eradicate than the fern, it is a serious obstacle to the cultivation of the land. It is effectually removed by incineration, and, at the same time, the tendency to produce it is greatly lessened.

Inequalities of surface often present themselves, and, to a certain extent, act as obstructions to tillage, by rendering the performance of the different agricultural operations greatly more difficult and expensive, but in general this admits of remedy only to a very partial degree; and it is only in the case of the inequalities presenting an abrupt surface, that any measure for procuring a more level one is to be undertaken. When the surface of the ground is unequal, the plough will suffice for levelling it in the common cases of tillage.

III.—PARING AND BURNING.

Paring the surface of the soil and burning the sods or turf thus obtained, are operations in husbandry which have been practised, for the improvement of the land, from a very early period. The practice is highly advantageous when judiciously executed; though, if the subsequent tillage and mode of cropping be improper, the soil is necessarily exhausted and essentially deteriorated. Hence it need not excite surprise, that the utility of paring and burning has been so much contested. The principles, however, on which this improvement is adopted, are now in a great measure ascertained.

The period at which the process must be performed is while the weather is sufficiently dry to admit of the combustion of the turf.

In favourable seasons it may commence in February, and the sods will thus be ready to receive the beneficial influence of the spring winds, which are so distinguished for their drying properties. The burning may begin in March, and be continued, as convenience or the state of the weather allows, till the end of September. What is earliest done may be planted with potatoes, the next in succession may be sown with turnips, another portion with rape, and what is executed late may be reserved for rye, or, on good soils, for wheat. Thus the improvement would be carried on through the season without interruption.

The instruments employed in paring the turf for the operation are either a species of spade, pushed along partly by the hands, and partly by the pressure of the breast, and thence termed a breast-plough; or by a plough so formed as to cut and lay on its back a thin sward of turf.

The spade, or breast-plough, is a triangular-shaped instrument, about thirteen inches in length, having on the left-hand side a small wedge turned up like a coulter, which separates the sod from the unremoved surface. The blade is about a foot broad at its insertion with the handle. The shaft is of wood, made with a considerable inclination upwards, and is about seven feet in length. At the upper end is placed a cross handle, about two feet long, not thicker than a man can grasp in his hand, and upon which he presses with his breast. It is thus pushed forward, cutting the surface into pieces of about two feet in length, which are turned over on the right side by a wrench of the spade given by the workman.

The operation of the breast-plough is generally aided by a broad axe, or mattock, which is used for cutting up the stems of furze, which offer too great resistance to the blade of the former, and, in particular situations, is found indispensably necessary, as the nature of the ground sometimes renders the action of the plough or paring-spade impracticable.

When the sod or turf is pared by these means, it is dried preparatory to burning. This is commonly done by letting the sods lie as the paring instrument let them for several days, thus drying their earthy side, and then turning the grassy side upwards for a few days longer; and, if more drying should be necessary, they are placed on their edges, two sods supporting each other, by which both sides dry at the same time.

When the sods are dry enough to burn, they are collected into heaps, and set on fire, the heaps being so covered that they shall burn with a smothered heat. More or less firing is required in proportion to the adaptation of the soil for burning, of which an experienced workman can easily judge. The fire should be applied to the sheltered side of the heap; and if the sods lie close, and the fire is kept in by stopping up any places where it breaks through, and covering the whole with fine mould, after the materials are properly ignited it never fails to burn well.

When the heaps are burned, the ashes are spread abroad upon the surface, if it does not require any previous levelling, and covered by a shallow ploughing. It is of importance to sow the seed as soon as possible after the ashes have been spread and ploughed in; for they operate much more powerfully when in a caustic state, and the succeeding crop will be more abundant.

It is extremely material that the first crop produced after the process of incineration should not be of an exhausting kind. The effects of paring and burning upon the land are analogous to those produced by the application of calcareous matter, acting rather as a stimulant than in adding fertilizing matters; and when the powers of the soil are thus excited and called into action, severe cropping will have the effect of completely exhausting it, and rendering it, for a series of years, totally worthless. Turnips, rape, or tares, are generally recommended, or potatoes, when the process is performed early in the season, and some dung can be applied. Turnips or rape, fed off with sheep, form the most proper crops which can be cultivated on land after paring and burning.

By the process of paring and burning, a stiff, damp, and, consequently, a cold soil will be converted into one that is friable, dry, and warm, and better fitted for the support of vegetation. The effect of the process, in changing the constitution of tenacious clayey soils, may be judged from the change which takes place in clay while being converted into bricks. If, for example, we powder a brick, we shall find that, in this state, the clay possesses properties extremely similar to those of sand, namely, that when mixed with water, its particles do not adhere together, and form a cohesive plastic mass. The chemical change which it has undergone prevents it from combining with water; for, being once completely deprived of it, there is extremely little chance of alumina being ever afterwards converted into a hydrate. Moreover, during the process of burning, the alumina enters into chemical union with the silica and iron of the soil, should any exist, and forms with them insoluble compounds, which are decomposed with great difficulty, and, in this manner, the injurious effects of the oxides or salts of iron existing in the soil may be completely neutralized. Hence, then, the composition of clayey soils is not only improved by an alteration of their texture by the process of burning, but certain noxious matters are deprived of their deleterious properties. The quantity of matter which has been thus altered in its texture is, indeed, comparatively small; but still it is so great that its effects are perceptible for a number of years.

Since the attention of physiologists has been directed to the hypothesis, that certain excrementitious substances are thrown out by the roots of plants into the soil, it has been considered that no small share of the good effects of paring and burning is to be attributed to the destruction of these pernicious matters. Further experiments are yet wanting to determine how far this supposition may be correct; but it is certain that the importance of the changes thus produced in the soil has been greatly overrated, even should they be, to a certain degree, beneficial. In the present state of our knowledge of the subject, it seems much more reasonable to attribute the good effects resulting from the changes produced in the soil by incineration, to the alteration of its texture, both mechanically and chemically, and the increased operations of matters before inactive.

Paring and burning is objected to on the ground that it tends to exhaust the soil of its permanent sources of fertility, by dispelling the soluble matters which it contains. Though some animal or vegetable matter, previously existing in the soil, may thus be dissipated, yet such temporary disadvantages are amply compensated by the destruction of the seeds of weeds, as well as by the texture of the soil being permanently improved. In regard to soils in which there is an excess of inert vegetable matter, the getting rid of that excess must be beneficial; for the remainder will be rendered better calculated for agricultural purposes. This is particularly the case in respect to the vast tracts of peat-moss which cover so large a portion of the surface of this country.

The indiscriminate paring and burning of sound dry land, which has been long under tillage, and which is clothed with sweet herbage, has, indeed, been permanently injurious wherever it has been attempted. On lands where the surface soil is capable of producing crops by cultivation, and a judicious application of manures, paring and burning may be regarded as a most pernicious practice. In the greater number of cases, the quantity of ashes produced bears but a very small proportion to the bulk of soil consumed; and when the surface is thus reduced to ashes, it is evident that the productive powers of the soil are injured for a great number of years.

It is obvious that, in all cases, the operation of paring and burning must destroy a certain portion of vegetable substance, and it, therefore, can be only really useful where an excess of this matter exists in the soil in a dormant state; for the accumulation of rank herbage and woody fibre, with which some land is overrun, can only be slowly reduced to the state of mould when left to the natural process of decomposition; nor is it easily brought into a fit state for the immediate purposes of cultivation, even by the application of lime.

Injudicious cropping after the process, has not a little tended to bring it into disrepute. Nothing new is added to the soil by paring and burning—that already existing is only made available. If successive crops of corn, therefore, be taken off the land, it will, in a few years, become exhausted, and will require a great length of time before its fertility is restored. The first crops are generallly great, and farmers, thus induced by the profits immediately obtained, too often repeat the exhausting crops without the intervention of restorative ones, or any application of dung to restore the exhausted powers of the soil, which, being forced to its utmost production by the stimulus given to it, is at length brought to a condition of utter worthlessness, and altogether unfitted for the purposes of tillage.

But although the advantages resulting from paring and burning may be abused, it by no means follows that it should not be practised in cases when there is an excess of vegetable matter in the soil. It is, indeed, a powerful agent in the reclamation of land. The chief cause of infertility in peaty and moory soils proceeds from an excess of vegetable matter, unsuited to the support of vegetable life; and although the quantity of ashes produced from burning on this class of soils is comparatively small, yet the advantages resulting from clearing the soil of a portion of this excess, are sufficient to justify the adoption of the process. Previous and effectual draining is, however, in all cases, indispensable; but that work accomplished, and paring and burning will be found effectual in removing all excess of inert matter.

IV.—FALLOWING.

When the soil has been for a long period exposed to the weather, however well pulverized it may have been at first, it will—unless it consists almost entirely of silicious matter—become cosolidated to a greater or less extent, and thus be rendered unfit for many of the operations of husbandry. Moreover, if, in addition to mere exposure, it should have an abundance of vegetation upon it, the root fibres of all these plants will of course remain in it, and thus tend, in a still greater degree, to bind it together. To obviate these difficulties, as well as to facilitate various other processes, farmers have, from time immemorial, had recourse to various mechanical operations for restoring the soil to its original state; these are ploughing, harrowing, and the like, by means of which the earth is fully broken up, the root fibres which it contains completely separated, and the soil reduced to a comparatively fine powder. These processes are termed fallowing; and during the period in which they are performed, the land is said to be in fallow.

Fallowing, then, is a mode of preparing land for the production of crops by repeated ploughings, for a considerable time before it is finally ploughed for the seed. Fallows are of two kinds, namely, green-fallow, so called from the land being cleaned under a green crop, such as beans, potatoes, or turnips; and naked, bare, or summer-fallow, so named from the land bearing no crop during the cleaning process in the summer season. The green-fallow differs from the bare-fallow chiefly in the several operations connected with the process being much more effectively executed in the latter case than in the former. The preparation of the land for fallow-crops bears a great resemblance to the operations of the summer-fallow; but, being performed at a season at which all agricultural operations in the fields are executed with difficulty, the green-fallow is necessarily defective in many respects.

In the process of fallowing, whatever be the nature of the land to be fallowed it is to be ploughed in the autumn, that it may receive the influence of the frosts of winter to pulverize the soil and check the growth of weeds. This ploughing is to be given as deep as the plough can be made to go, even should a portion of the till or subsoil be brought up. This tends to deepen the cultivated or manured soil, and greatly facilitates the separation of root weeds during the ensuing fallow process, by detaching them completely from any connexion with the subsoil.

In order to effect the thorough pulverization of the soil to a sufficient depth, it is sometimes necessary to give a deeper ploughing than the depth of an ordinary furrow. This may be effected by what is termed trench-ploughing, in which case, a second plough, deprived of its mould-board, follows in the newly-opened furrow, and brings up an additional portion of fresh earth. The subsoil-plough will, in this case, be found a most efficient instrument, being of great utility in stirring the subsoil without mixing an under proportion of it with the upper stratum.

In giving this first ploughing, the old ridges should be gathered up, if the land has the least tendency to wetness, as, in that state, it is kept dry during the winter months; but it is not uncommon to split them out, thus dividing each ridge into two, especially if the land has been previously highly gathered. Sometimes, when the land is easily laid dry, the furrows of the old ridges are made the crowns of the new ones, or the land is ploughed in the way technically termed crown-and-furrow. In whatever manner the ridges are ploughed, they remain in that state to the following spring; care, therefore, must be taken to carry off stagnant moisture, by making outlets from every hollow part of the field. After the field is ploughed, all cross-furrows and head-lands are accordingly carefully opened up by the plough, and afterwards gone over by a workman with a spade, to remove all obstructions, and to open up all the water-furrows into the ditches of the field, wherever it seems necessary to do so, that water may have a ready exit. In every place where water is expected to lodge, such as the hollow places of the field, cross or oblique furrows are to be drawn by the plough, and their intersections carefully opened into each other by the spade.

As soon as the spring seed-time is over, the working of the fallow is again to be resumed, another ploughing being then given. It is found desirable, in this ploughing, to run the furrows directly across the former ridges of the field, as the surface is thus effectually cut into pieces. These not being able to resist the pressure of the mould-board, are generally thrown up in an irregular manner, and present to the inexperienced eye a confused aggregation of lumps of earth. Such a state, however, is well adapted for exposing a very enlarged surface of the soil to the ameliorating influence of the atmosphere; and if the weather continues dry after the ploughing, the weeds will receive a check in their growth.

The land is to lie in this state until the surface is dry, which is indicated by the change of colour in the soil. In the meantime, the potato and turnip lands are worked, and the other green crops put in the ground. When the surface has become partially dried, and before the lumps previously turned up become too hard, the harrows should be set to work, to break down all these confused lumps into a uniform surface. These harrowings should be repeated three or four double times, at right angles each time, as the object now is to loosen every particle of weeds, and bring them to the surface of the ground. In light lands, this ploughing and the subsequent harrowings, more than any other, destroy weeds; and, upon such lands, they should be collected into heaps after the action of the harrows. On the heavier soils, the weeds are also to be collected; but the roller must previously be employed for crushing the indurated masses of earth in which many of the weeds would otherwise be retained.

The power of vegetation, at this period of the year, will cause weeds to increase very much, and if not eradicated great additional labour will be required to keep them in subjection. All weeds brought to the surface are to be carefully collected into heaps by the hand, or by rakes with the teeth placed close together. A cart then passes between the rows of heaps, and the weeders throw the weeds thus collected into the cart, by which they are removed to some convenient situation to be formed into a compost with quick-lime.

At this period of the fallowing process, drains may be advantageously formed in the field, and any small stones that may be lying on the surface should now be taken off, as obstructions to future work, and deposited at once in these drains. Large land-fast stones may also be taken out and rent into pieces with gunpowder, and their smaller pieces put into the drains. It is not, however, with the gathering of small stones as with weeds; the former are thrown into the cart at once, as gathering them into heaps does not expedite their lifting afterwards, they having, at all events, to be lifted again singly; but heaps of weeds which there has been much trouble in collecting, may be thrown into the cart at once, without delaying it.

The furrow to be given to the land, after this cleaning process, must of course be in a line with the ridges, in order to cut the former furrow, which was ploughed across; and this may be done by ploughing the ridges either singly, or two, four, or six of them together. The latter is fully the better plan, as it serves to keep the land flat, that is, it will not interfere with the future regular appearance of the ridges when they are gathered up. After harrowing this, two double times, at least, rolling and hand-picking weeds must be performed with great care, as the weeds being now not so numerous, and many of their roots having been broken by the plough and the harrow, they might be overlooked in performing the work in a hurried manner. These operations are performed in the month of June.

In the case of the lighter soils the tillage thus described will generally be found sufficient to produce the required tilth, as the weeds in them readily part with the earth from their roots, by which their removal is rendered less difficult. It is almost certain, however, that strong lands will require another furrow, which may be across, like the second, but only the furrow-slices of it reversed, or an angle furrow begun at one corner of the field and continued to the opposite one in an oblique direction to the ridges. Harrowing must again follow, and, if necessary, rolling; hand-picking weeds, and gathering stones, must also be repeated.

But instead of this last ploughing the grubber may be introduced as subsidiary to the action of the plough and harrow, in effecting the thorough pulverization and cleaning of the soil. By passing it over the field once, or oftener, in proportion as root-weeds are abundant, taking care at the same time to give a slight harrowing, and attentively to pick up every weed that appears, the soil will be completely cleared of weeds to the depth to which the teeth of the implement penetrated. The teeth of the grubber, it will be seen, are admirably adapted for bringing weeds which may be situated at some depth in the soil to the surface. The harrows are always to follow the grubber to collect the weeds which have been brought up and exposed.

After these operations have been performed, the land should be clean, if the weather has not been so moist, and warm, and sunless, as to encourage, instead of checking, the growth of weeds. It is here necessary to caution the farmer regarding the management of strong clays. Should the weather prove wet, or likely to be wet, it will be improper to risk strong land so long out of the ridge, as, if it be caught by much rain in a flat state, it will become soured before it is again so dry as to permit operations to be resumed. One cross-ploughing may be given in the spring, or early in the summer; but rather than risk any more, it would be better to plough the ridges together, backwards and forwards, casting them out, and ploughing them together alternately. In this way the furrows are always kept open for the passage of water.

Up to this period the preparation of the land for bare-fallow and fallow-crops is not materially different, with the exception of being performed at different seasons. The next process in the management of the summer-fallow is the formation of the land into ridges.

The surface having been completely levelled during the different operations of the fallow, it is now necessary to mark out the ridges, which is done in the manner formerly explained. This ploughing is always a gathering up. On light lands this gathering up, or crown-and-furrow, is all that is necessary for the seed-furrow, and it covers the manure which may be applied at the same time; but, on strong soils, a gathering up is usually given before the manure is applied, as it is necessary to keep such lands well rounded in shape, to prevent the rain or melted snow in winter injuring the wheat, or souring the land with stagnant surface-water.

In the application of the dung to the land, attention is to be paid to its distribution equally over the ground. The carter separates the load into heaps of an equal size, and places them at equal distances along the ridge. Occasionally the spaces for each load are marked off along the ridge to ensure regularity, but in general the workman by a glance of his eye will be able to deposit the manure with sufficient regularity.

The application of lime to land usually takes place during the season that it is summer-fallowed. It could not, indeed, be applied at any other time with greater propriety, as in this case it is mixed with the newly-turned-up earth, which it speedily converts into a fertile soil. As a matter of precaution, from the injurious effects of the caustic powers of the lime, the spreader should cover his face with a piece of thin linen or silk napkin; and the hind part of the horse employed in bringing it to the land should also be covered. A calm day, or the wind blowing on the side of the cart, is the best kind of weather in which to spread lime on land. Whenever the lime is spread, it must be immediately harrowed in whilst it is dry, as rain soon renders slacked lime an adhesive mass, which will not trickle down into the ruts formed by the harrow teeth, which it should do, to mix with the soil.

If land is to be twice ridged up for the reception of the seed, it is better to apply the dung at the first gathering up, and then to let it lie for some time to incorporate with the soil before it is seed-furrowed. In this case, the lime should not be laid on till immediately before the seed-furrow is given, and which, being a light one, will not bury the lime too deep. This mode has the advantage of spreading the lime above the dung, and the latter having a tendency to rise to the surface, is kept down by the former, which has a tendency to sink into the soil.

The operations of conveying the dung to the land, spreading it, and afterwards covering it by ploughing, are to be carried on in close succession. In a dry season this arrangement secures the dung being covered in quickly before it is injured by evaporation. These operations should be concluded by the end of July, after which the land lies with the dung in it till the seed-time. Wheat is the kind of grain which is almost always sown after the expensive bare-fallow, as the crop which yields the most profitable return from the land.

The ordinary operations of the summer-fallow have been now described; but the nature of the season, the state of the land, and other circumstances, will produce variations. The precise time at which the operations should be performed, and the manner in which they are to be executed, are best determined by the judgment of the farmer, as the cases themselves arise.

The several processes of ploughing, harrowing, and rolling, are admirably adapted for cutting the consolidated soil into pieces, for shaking the detached lumps of earth asunder, and for crushing every hardened ball of earth into which the fibres and roots of weeds might penetrate; and the hand-picking carries off every particle of weeds that might possess any latent vegetative power. Land that cannot thus be pulverized and cleared of weeds, must be excessively foul, the season very wet and unfavourable, or the fallowing process very imperfectly conducted. It must, however, be admitted that the fallowing is often performed in a careless manner. It is considered, by some, that the land can be cleaned at any time before the seed is to be sown in autumn, that weeds are easily ploughed down after they have made their appearance, and that the doing so assists to manure the land; but it is useless to attempt to show the absurdity of such opinions to any one who has paid the least attention to the subject.

Over a considerable portion of the United Kingdom it was long considered as an advantageous practice, occasionally to dedicate an entire season to the cultivation of arable land, without raising from it any crop. The expense of the process, and the sacrifice it occasioned, it was supposed, would be amply compensated by the texture of the soil being improved, by the destruction of weeds and insects which it occasioned, and by the increased produce of the succeeding crops. But when the rent of land was increased, the expenses of cultivation augmented, cleaning crops, as turnips, introduced, and the productions of the soil became more valuable, it was natural for the farmer to consider whether such great sacrifices were really necessary, and whether the practice might not be in many cases diminished, if not altogether abandoned.

Since the introduction of fallow crops, and the consequent increased degree of attention bestowed to the preparation of the soil, the summer-fallow has become less necessary, so that the farmer is now better enabled to avoid the practice of devoting an entire year to the cultivation of his ground, without any immediate return.

In so far as regards the exposure of the soil throughout the winter, the beneficial effects resulting from it are the same, whether the land is afterwards to be appropriated to the production of fallow-crops, or reserved for the more extended operations of the summer-fallow. This exposure of the soil during the winter contributes to the destruction of weeds, and to facilitate the more complete pulverization of it during the succeeding operations. One of the chief advantages to be gained by fallowing is, undoubtedly, the destruction of weeds, and, consequently, if the land be ploughed in the autumn to a considerable depth, and the under surface exposed to the severity of the winter, many of the tender fibres of the roots of these weeds are thereby destroyed, and the plants themselves perish. The exposure throughout the winter is also especially useful in breaking up obdurate masses of earth, which is effected by various means, but chiefly by frost. When it occurs, the water which is contained in the interstices of the clods of earth is converted into ice, during which change it is well known that it expands with great force. By this expansion the particles of earth are separated from each other, and the whole mass is rendered much more friable, and more easily pulverized afterwards during the succeeding operations of tillage. Thus far there is no distinction between the bare-fallow and the preparation of the land for fallow-crops.

But the changes produced in the land by the process of fallowing are not confined to the months of winter. Still greater beneficial effects must be produced throughout the summer months, or the sacrifice of the crop would be an unwarrantable waste, for which no corresponding advantage was derived. It is found that the operations of the fallow which are performed during the spring and summer, effectually check the growth of weeds, and still further contribute to the pulverization of the soil; and it is also ascertained that certain chemical changes are produced, by which insoluble compounds are rendered soluble, and available for the purposes of vegetation. But the operations in the preparation of the land for fallow-crops are extremely analogous to those performed in the process of the summer-fallow, differing, as has been seen, only in the time at which they are executed.

With all this similarity apparently existing between the effects produced by the summer-fallow and the cultivation of fallow-crops, it is found that these effects are produced in different degrees. In the latter case the essential fallowing operations are indeed performed, but at a season in which their execution is necessarily imperfect; it being well ascertained that the operations of tillage cannot be performed at an early period of the season without difficulty. On strong clay soils, and even on the lighter soils incumbent upon impervious strata, it is almost impossible to commence operations early in the spring in any season, but particularly in a wet one; and when the weather comes in very dry, such lands get so hard that the pulverization of the soil by harrowing and rolling, which are necessary for effectual cleaning, cannot be accomplished in time for most of the fallow-crops; besides, it is found that a rapid succession of similar operations on the same piece of ground does not work the land so beneficially as the same labour would do when bestowed at proper intervals. The defective tillage necessarily given at this period is, in some degree, compensated by the after culture of the crop; but, even in the most favourable cases, the substitution of fallow-crops must be regarded only as an approximation to the more perfect tillage given when the land is summer-fallowed.

There cannot, however, be a doubt that it has become less necessary on the lighter soils since the introduction of the improved turnip husbandry; and it is chiefly on the stiffer clays that the summer-fallow may be held to be an essential branch of farm management in this country. But even on the stiffer clays there is ground to hope that, in process of time, circumstances may occur which will prevent the necessity of recurring so frequently to the bare-fallow, as is requisite at present. The climate will improve as cultivation advances; by more effectual draining, and frequent additions of lime and dung, the texture of the strongest soils will be altered; by repeated cleaning and careful tillage the quantity of weeds of all kinds will be lessened; and in consequence of all these changes the cultivation of adhesive soils will be rendered much less difficult. But until these desirable results are attained, the summer-fallow will continue to be an important object to the farmer.

VII.—STRUCTURE AND FUNCTIONS OF PLANTS.

The cultivation of the various agricultural plants is by far the most important of the labours of the husbandman. The spontaneous productions of the earth are only sufficient for satisfying the wants of man in a rude state of society; but, as civilization advances, a taste for the comforts and luxuries of life is manifested in a greater degree, and the cultivation of the soil becomes important in order to produce a greater quantity of vegetable food, and that also of a superior quality.

Vegetables differ from minerals in being organized bodies, possessed of a degree of life, and capable of taking into their system extraneous matters, and converting these by an assimilating process into new compounds, which matters are thus rendered subservient to their growth, and development. They thus increase their own bulk, and, moreover, throw off from their own bodies germs which spring up into other vegetable bodies, the same as the parent plants. Vegetables also are under the dominion of the laws of vitality, by which they retain the matters entering into their structure, in a state different from that in which inorganic bodies exist. The matter, too, which enters into the composition of vegetables is essentially the same as that which forms the structure of animals; the chief elementary ingredients being oxygen, hydrogen, carbon, and azote; only the proportions and combinations are somewhat different, vegetables possessing more carbon and less azote than the generality of animals. In these respects, vegetable bodies closely resemble animals; indeed in the lower divisions of each, the resemblance is so close as to render it a somewhat difficult task to point out the distinctive differences. We find no hesitation in drawing a line of distinction between the more perfect plants and a quadruped, bird, or fish; but, if we take some animals low in the scale of organization, and compare them with certain simple vegetables, we shall find the resemblance, both of structure and functions, very close indeed.

Vegetables, like animals, are acted upon by the external agencies or stimuli of life, as heat, light, air, moisture, and electricity; and the vital laws by which they are governed place them in a totally different position from inorganic matter. In the tubes of vegetables, the sap ascends from the earth, contrary to the laws of gravity, and the juices and whole material of the plant, as long as it is possessed of life, resist the common chemical laws of decomposition, but whenever it is cut down or deprived of life, these juices immediately run into fermentation, and again return to the elementary matters, of which they were originally composed.

The number of vegetable forms on the surface of the globe is immense. At least 50,000 have already become familiar to botanists, and as every new exploration of recently discovered regions is adding rapidly to the list, the probability is, that at least twice this number exist in nature. The past history of the earth, too, informs us, that many vegetable forms, which once flourished in great luxuriance and profusion, are now swept from the soil, and no longer exist, but in their fossil forms in the rocks and strata.*

As in the case in the animal kingdom, we find that the tribes and families of vegetables vary exceedingly in their forms and sizes. Some are so minute as to be invisible to the naked eye, others rise to the height of several hundred feet, and occupy an area of several square yards with their ramifying foliage.

The lowest tribe of vegetables are not only minute but simple in their structure. The blue mould, *Fig.* 46, found in bread and other farinaceous articles of diet, when examined by the microscope, will

Fig. 46.

Fig. 47.

Fig. 48.

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* Rhind's History of the Vegetable Kingdom.

be seen to consist of a number of upright stalks, surmounted by spherical bulbs, at the top. This mould is, in fact, a species of fungi, and the round heads contain innumerable small black seeds or sporules, which when the plant has arrived at maturity, burst from their covering, are scattered about, and floating through the atmosphere, are ready to fall on other pieces of bread, and grow up into fresh fungi. If an apple is cut across, and allowed to remain in a damp situation for several days, the surface will also be covered with a mould of a similar character. The fungi here have more of the arborescent form, and approach somewhat to the mosses. *Fig.* 47 represents the apple mould, and *Fig.* 48, the pear mould. The gray lichens which so abundantly encrust rocks and stones are also simple vegetables, produced from a small seed, which, fixing itself on a flinty rock, by means of a tough mucilaginous juice, becomes the centre from which others radiate, until a large circular patch is produced. Mosses and ferns are vegetables somewhat more complicated; and hence we ascend to herbs and shrubs, the towering palm and the majestic oak of the forest.*

A knowledge of the structure and functions of plants is of the first importance, as laying the foundation of an economical system of culture. The necessity of becoming acquainted with the various phenomena of the vegetable economy is apparent, in order that the cultivator may avail himself of the great influence exercised by human agency over the productions of the vegetable kingdom to the greatest extent. Apart from any considerations of profit, the study of the vegetative process affords greater pleasure than that of any other branch of natural science. But if we can influence a seed so much that, instead of growing up into a useless stinted stalk, fit only for the herbarium of a botanist, it shall spring up luxuriantly and send forth such a profusion of stems as to form a little sheaf of corn; or expand its root, which may be naturally hard and useless, into a large esculent mass weighing many pounds;† and if we can do all this without knowing more than the means we have employed, might we not anticipate still greater and more wonderful effects, were we acquainted with the processes of the vegetable economy, by which such happy results were obtained? We should then be able to know what it is in our culture that has aided, and if there be any thing in it that has obstructed the processes of nature.

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* Rhind's History of the Vegetable Kingdom.

† In the Philosophical Transactions for 1768, an account is given of a process by which, in a single season, one grain of wheat produced 21,109 ears, or about 576,840 grains, nearly one bushel of clear grain; and roots have been repeatedly exhibited at agricultural meetings, weighing from twenty to thirty pounds.—*Quarterly Journal of Agriculture*, vol. i.

The importance of acquiring a certain knowledge of vegetable physiology cannot be pressed too much upon the attention of the cultivator. By means of selecting and improving the varieties of plants, the produce of our gardens and fields is not only increased in a tenfold degree, but the *quality* of the produce is increased in a still greater proportion. The rose is the offspring of cultivation; the original plant, from which all our beautiful varieties have proceeded, is considered by botanists to be the common wild briar. Our plums are cultivated descendants of the sloe; the delicious apples, whose species may be reckoned by hundreds, are the cultivated successors of the small austere crabs; and our cauliflowers, cabbages, and other esculent vegetables, may be regarded as almost artificial products, so much has human skill had to do in their production. Here the labour and assiduity of man are seen triumphing over the sterility of unassisted nature, and succeeding in bringing forth a race of beings calculated to supply his wants in a manner that the original species never could have done.

If the faculty of increasing the stores which nature has already provided for his support, raises man above the brute, that of adding new productions to those in existence, raises him above his fellow; and few subjects of contemplation can be more gratifying, or more elevating to a reflective mind, than this power, as it were, of creation, granted to his intelligence and industry. Nor is it necessary to its enjoyment, that we should be either botanists, or natural philosophers; or that we should devote more than occasional leisure hours to the pursuit. So boundless, indeed, is the scope which it affords for experiment, that it is in the power of any one possessed of the smallest garden, and the least acquaintance with the principles of culture, so to improve the qualities of its products, as to add something to the common stock. While the farmer, who will take the pains to mark the progress of his crops, and to select from them the most productive ears of corn, and the finest roots and grasses, for seed, may, by perseverance in such a plan, not only acquire wealth for himself, but confer an inestimable benefit on his country.

I.—THE SEED.

With the fact we are sufficiently familiar, that, when a seed is deposited in the ground, under certain circumstances, it will spring up into a plant of the same species as that which produced it. As this is a primary law in the vegetable economy, we shall proceed to investigate the circumstances under which it takes place, and, perhaps, from the knowledge thus acquired, we shall be able to attain a certain power over the process. There are two things essential to the growth of a seed, the one relating to the state of the seed itself, and the other to the circumstances in which it is placed. The former of these shall be first considered.

In treating of the functions of the seeds of plants, it is necessary to distinguish between that which is seed, *properly so called*, and other parts of plants, which, as they serve the same purpose, are *conveniently so called*. We speak of seed-wheat and seed-potatoes; and it may be convenient to call potatoes which are to be planted by this name; but of the two, wheat can only be properly called seed.

With the exception of what is termed cryptogamic plants, such as ferns, mosses, or fungi, there is a great similarity between the structure of all seeds. They are all provided with an envelope, or outer covering, suited to the nature of the particular seed, and the need which it has for protection; and seeds are, in every instance, covered with one or more coats to defend them from excessive dryness or moisture, or from the voracity of animals. There are no naked seeds, strictly so called, in other words, none which are not covered by a *pericarp*. But this latter organ is sometimes so thin, or adheres so closely to the seed, that it cannot easily be distinguished at the period when the seed is ripe, on account of their being intimately attached to each other, and conformed, although the two parts were perfectly distinct at a former period in the maturation of the seed.

The outer covering of the seed seems to serve the purpose of protection only, to effect which, it is often of a very hard or tough consistence, while the inner coat seems to serve chiefly for nourishing the kernel within; and for this end, it is composed chiefly of a network of sap-vessels. The outer coat is entire in every point, except one, where a scar is always observed to be upon it. This scar marks the spot where nourishment passed into the seed, while it remained in the seed-vessel, or pod, by a cord, termed the *umbilical cord*, consisting of an aggregation of extremely minute sap-vessels, which, after reaching the seed, penetrated its outer covering, and branched over the surface of the kernel, constituting in this way the framework of the inner coat.

The outer covering of the seed, in many cases, promotes their dispersion, by opening, when ripe, with a sort of sudden spring, ejecting the seed with violence, and throwing it a considerable distance from the parent plant. If seeds were to fall, merely by dropping down from the plant, the great mass of them, instead of germinating and springing up into distinct plants, would grow only to putrefy and decay; but, to prevent this consequence, they are often supplied with a downy covering, or an elastic pericarp, which serves to waft them through the air, and thus promote their dispersion. It is extremely interesting to observe the various means for the dispersion or dissemination of seeds. As a curious example, every one is familiar with the down of the thistle and dandelion, and many others; and upon examining the mechanism of these parts more minutely, it will be found that there is a peculiarity in their arrangement, causing the whole to ascend in the air, though it be not specifically lighter. Various other agencies are exerted in the diffusion of seeds, but they are, in a great measure, unconnected with the structure of the seed itself.*

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* The fecundity of plants, in other words, the astonishing number of germs or seeds which they produce, is one of the causes which are most powerful in facilitating their reproduction, and in effecting their surprising multiplication. A single capsule of the white poppy has been know to contain 8000 seeds, and a single capsule of the *vanilla*, from 10 to 1500; a single stalk of *zea mays* will produce 2000 seeds; a single spike of *typha major*, or greater cat's tail, 10,000; a single plant of tobacco has been found by calculation to produce the almost incredible number of 360,000; and a stalk of spleen-wort has been thought, by estimation, to produce at least a million of seeds. Let one imagine the regularly increasing progression of this number, merely to the tenth generation of these plants, and he will hardly conceive how the whole surface of the earth should

The scar, or *hilum*, has been said to be the part at which nourishment was conveyed to the seed by means of the umbilical cord. It is frequently of a different colour from the rest of the outer covering, and is often nearly black. In plants having small seeds, it is exceedingly minute, and recognized with difficulty; but in some it is so large as to occupy fully a third part of the whole surface of the seed, as in the horse-chesnut and some others. In grasses, the hilum is indicated by a brownish spot, which is usually easily observable.

The *embryo* is a fleshy body occupying the interior of the seed, and constituting the rudiment of a future plant. It is usually solitary, but there are instances of the presence of several in one seed. It was originally formed in the midst of the pulpy substance of the kernel, and is nourished by this substance during its growth. This pulpy matter bears, apparently, much the same relation to the embryo plant as the white of an egg to the embryo bird; and hence it has obtained the name of *albumen*. In a number of cases, it is so wholly absorbed by the embryo, that no trace of it is left behind; but in others, the albumen remains interposed between the embryo and the integuments, or covering of the seed, in the form of either a horny, mealy, or oily substance. These differences in its texture are owing to the nature of a substance secreted during the formation of the seed within the cellular tissue of the kernel, and replacing the fluid matter consumed by the embryo. In the seeds of the cereal tribe, this substance consists of farinaceous matter, adapted for human food; in coffee, of a stimulating secretion, the infusion of which forms a grateful and well-known beverage; and in the poppy, of a greasy matter, from which a valuable oil is extracted.

Upon certain remarkable differences in the structure of the embryo, modern botanists have divided the whole vegetable kingdom into three great portions, which form the basis of what is called the natural system. These are, 1. *Dicotyledons ;* 2. *Monocotyledons ;* and 3. *Acotyledons.* The third class, or acotyledons, are the cryptogamous

not be covered by them. But many causes tend to neutralize in part this astonishing fecundity, which by its very excess would prove injurious to the reproduction of plants. All seeds are not placed by nature in circumstances favourable to their development, besides numerous animals, and man himself, deriving their principal nutriment from fruits and seeds, destroy incalculable quantities of them.—*Rhind's History of the Vegetable Kingdom*, p. 98.

plants already alluded to, and, not being agricultural plants, they do not require especial notice here. In order to understand exactly the nature of the others, it will be requisite first to describe fully the embryo as it exists in dicotyledons, and then to explain its organization in the monocotyledons.

This division of the seeds of the common cultivated plants is also important, as being characteristic of the qualities of the plants themselves, as well as of the seeds from which they are produced. Were it, indeed, the case that the distinction extended only to the latter, little advantage would be gained by its adoption ; but, so far is this from according with the fact, that it is interesting to observe with how great and uniform a difference of structure in the plants that grow from them this variation in the structure of their seeds is associated. Thus, in the class of monocotyledons, we have plants, the stems of which are like canes, or hollow, or jointed, but, never divided into bark, wood, and pith; the leaves of which are rarely opposite to each other, having, in general, undivided nerves running along them ; and, in the different parts of the flower and fruit, the number three prevails in a very remarkable manner. In the other class, again, the stem is divided into bark and wood, it being from the plants of this class that true wood is obtained. The leaves of the species included in it are beautifully netted over by the crossing of the nerves, which do not run to parallel undivided threads, as is generally the case in the monocotyledonous plants; and, in the parts of the flower and fruit, the number five is as remarkably prevalent as three is in the others. But these peculiarities may be passed by, while we proceed to a more minute account of the structure of each.

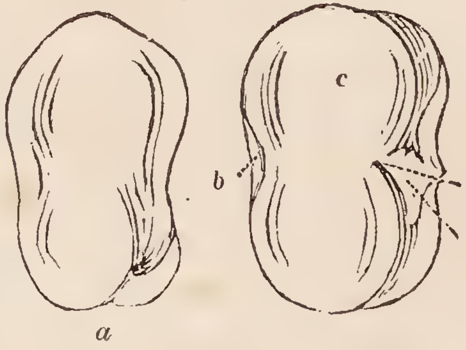
If a common dicotyledonous embryo, that of the apple for example, be examined, it will be found to be an obovate white fleshy body, tapering and solid at the lower end, and compressed and deeply divided into two equal opposite portions at the upper end ; the lower tapering end is termed the *radicle*, and the upper divided end consists of two *cotyledons*, or seed-lobes. Within the base of the cotyledons a minute point, or speck, may be observed, which is called the *plumula*, from which the stem of the future plant proceeds in the process of germination, this being the line of separation between the stem and root of the plant.

The embryo of monocotyledons is usually a solid cylindrical undivided, homogeneous body, slightly conical at each extremity, with no obvious distinction of radicle, plumula, or cotyledons. In germination, the upper end swells and remains within the *testa* or coverings of the seed; the lower lengthens, opens, and emits from within, one or more radicles; and a thread-like green body is protruded from the upper part of the portion which is lengthened beyond the testa. If this is compared with the germination of dicotyledons, an obvious difference will be at once perceived in the manner in which the radicles are produced; in the former case, they are emitted from within the substance of the radicular extremity, and are actually sheathed at the base by the lips of the passage through which they protrude; while, in the latter, they appear at once from the very surface of the radicle extremity, and, consequently, have no sheath at their base.

In selecting seeds for examination illustrating these classes, it will be important to choose such as are generally familiar to every one, the structure of which is, of course, well known. We shall, therefore, describe successively the structure of the common bean, and of a grain of wheat.

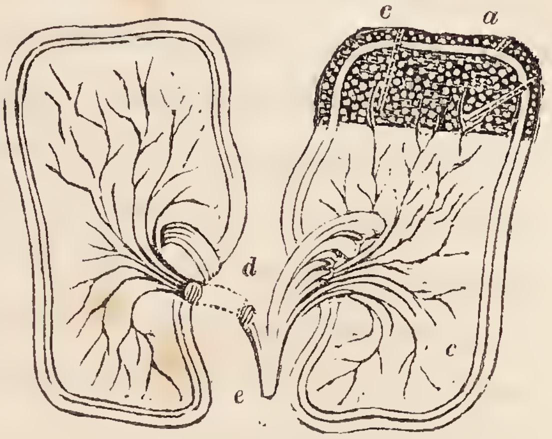
On examining the seed of the bean, the hilum, or scar, *a*, is easily distinguished, being usually of a darker colour than the other parts of the seed. This, it has been said, is the part by which it was attached to the pod, and through which the umbilical cord entered for the nourishment of the seed. The testa, or skin, is found, on dissection, to consist of two coats, the outer of which is very thick and tough, when compared with the inner one. The kernel is composed of two cotyledons, *c c*, with their edges often overlapping each other, as at *b*, and united together by a band, *d*. From the middle of this band, the plumula is seen to protrude. The cotyledons constitute the mass of the seed, and are filled with the mealy or nutritious matter destined to nourish the young plant, until it can derive nourishment from the soil, and to digest that nutritious matter, so that it may exist in the state best calculated to effect the object in view.

Fig. 49.



The organization of the seed will be more fully understood by inspecting the annexed figure, which represents a bean magnified and laid open. The skin, *a a*, is seen to consist of a number of small cells, to which the term *cellular tissue* is applied. The cotyledons *c c*, have a similar structure, in the cells of which the nutritious matter is deposited. Ramifying through this cellular mass, and converging to a point, are a great many sap vessels, which serve to convey the nourishment to the rudimentary plant, which is also seen at *d*. They bring it first towards the root *e*, after which it is carried up into the stem.

Fig. 50.



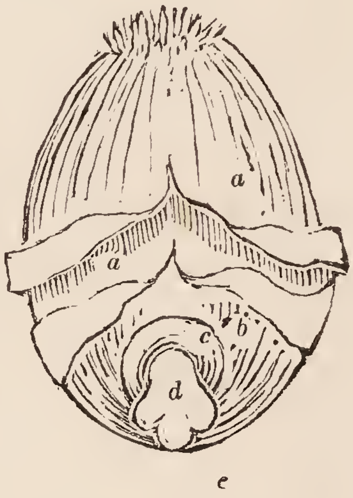
This description is applicable to most of the species of dicotyledonous plants, but there are many modifications which it is not necessary to detail. Thus, sometimes the cotyledons rise above the ground, as in the case of the turnip, the beech, the plane, and many other seeds ; at other times, again, they remain in the ground, as in the bean and pea. They are generally entire in their form, but sometimes very much divided, as may be observed in garden-cress, and the different species of pine. The nutritious matter, too, instead of being diffused through the cellular structure of the seed-leaves, is sometimes situated in a little sack behind them, as will be seen in the case of wheat. In short, there are a great many modifications of structure, but they are interesting only to the systematic botanist, and, in a general view of the vegetable economy, need not be more minutely noticed.

There exist many points of resemblance between the structure of a grain of wheat and that of the bean just described, but they differ in the latter having only one seed-lobe, while the former has two. The testa is found to consist of an outer and inner covering, the thickness of which varies with the kind of wheat and the climate in which it is produced. A general law is, that the more severe the climate the thicker is the skin of the seed. It is these skins which, when broken by the process of grinding, constitute the bran of wheaten meal.

The kernel is found to be composed of three parts, in conformity with the general structure of seeds already related ; and one of these constitutes almost the whole bulk of the grain. This is the nutritious matter which is contained in a little sack, close in every part except the base where the sap-vessels enter, and, after passing through the cotyledon, contribute to the support of the embryo plant.

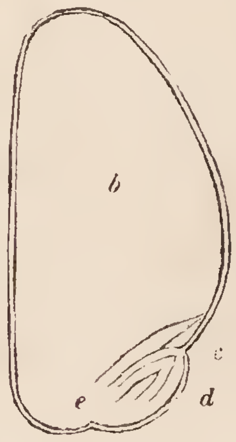
In *Fig.* 51, which represents the grain laid on its flat or furrowed side, *a a* represents the two coats which are torn open to show the structure of the kernel ; *b*, the sack of nutritious matter which constitutes almost the whole of the seed ; *c* is the cotyledon, through which the nutritious matter passes when the grain is germinating, and by which it is reduced fit for the nourishment of the little plant. The rudimentary plant is seen at *d*, at the base of which there are three tubers, from which as many roots or stems, or both, will afterwards proceed : *e* is the point where all the three, namely, the nutritious matter, the cotyledon, and the rudimentary plant, are united.

Fig. 51.



A longitudinal section of the grain of wheat is represented in *Fig.* 52, it having been cut by a knife laid along the furrow. The skins are not so distinctly seen as in the last figure : *b* is the nutritious matter ; *c*, a section of the cotyledon ; *d*, a section of the rudimentary plant, from which it is seen to consist of leaves rolled together ; and *e* is the point of junction.

Fig. 52.



All the parts which have now been described are essential to the growth of the seed. If the nutritious matter, or albumen, be not present, there is nothing to nourish the rudimentary plant ; for it is not yet sufficiently developed to draw nourishment from the soil. If the rudiments of the little plant be not present, there is nothing which can be converted into root and stem ; and experiment has equally proved the presence of the cotyledon to be essential to the germination of the grain ; for, as often as it was cut away, no matter how carefully, the seed failed to vegetate.

The embryo, it has been seen, is the already organized body, existing in a perfect seed after fecundation, and which constitutes the compound rudiment of a new plant. When placed in favourable circumstances, it is converted by the act of germination, into a plant perfectly similar, in every respect, to that from which it derived its origin. In the embryo, before germination, the radicular extremity, or that which gives rise to the root, is always simple and undivided. When it begins to be developed it often sends off several small knobs, which constitute so many radicular filaments, as in the gramineæ. If, in some cases, it is difficult, before germination, to distinguish the radicles, it becomes easy to do so when the embryo begins to grow. Thus the radicular body always tends towards the centre of the earth, whatever impediments may be put in its way, and changes into a root, while the other parts of the embryo take an opposite direction.

The term *germination* is applied to the series of phenomena through which a seed passes, when having arrived at state of maturity, and being placed in favourable circumstances, it swells, bursts its envelopes, and tends to develope the embryo which it contains. Before a seed can germinate, there must, however, be a concurrence of circumstances favourable and essential to this process.

An important condition to the healthy and vigorous germination of the seed is, that it must previously have reached maturity. Unripe seeds seldom germinate, because their parts are not yet prepared to form the chemical combinations on which germination depends. There are some seeds, however, whose germination is said to commence in the very seed-vessel, even before the fruit is ripe, and while it is yet attached to the parent plant. But these are examples of rare occurrence, though it is sometimes necessary to sow or plant the seed almost as soon as it is fully ripe, as in the case of the coffee-bean, which will not germinate unless it be sown a few weeks after it has been gathered. Most seeds, however, if guarded from external injury, will retain their germinating faculty for many years.

A second condition necessary to germination is the access of heat. No seed has ever been known to germinate below the freezing point. Hence seeds do not germinate in winter, even though deposited in the proper soil ; but the vital principle is not necessarily destroyed in consequence of this exposure of the seed, for it will germinate in the spring, when the ground has been again thawed, and the temperature raised to the proper degree.

Another essential condition is the access of moisture. Seeds will not germinate if kept perfectly dry. Water, therefore, or some equivalent to it, is indispensable—hence rain is always acceptable to the farmer and gardener, after they have sown their seeds. But the quantity of moisture is also a matter of importance, as there may be too much or too little; in the former case, the seeds burst and rot, and in the latter, they remain inactive in the soil.

The access of atmospheric air is also a necessary condition to germination. Seeds will not vegetate if placed in a vacuum, no matter how favourably situated soever they may be in other respects. This has been repeatedly proved by placing seeds in moist earth, in the vacuum of an air-pump, and they remained inactive during the period that the air was withdrawn; but, on its readmission, germination took place.

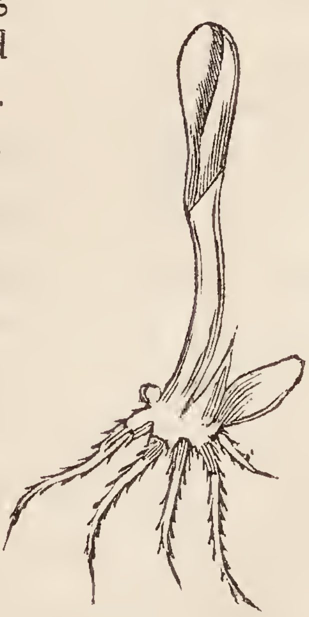
When a well-organized seed is placed in a situation in which the foregoing conditions are fulfilled, it speedily undergoes a change. It absorbs moisture and increases in bulk; but if it should have previously met with any accident to destroy its vitality, its organization decays, and it becomes putrid. The same effect takes place though the seed be alive, unless air is present; but if the seed be good, and air and moisture present, with the requisite degree of heat, this swelling of the seed from the mechanical imbibition of water is but the first of a series of interesting changes. The nutritious matter becomes fluid, milky in its aspect, and sweetish to the taste. It then goes to the support of the rudimentary plant, first towards the root, and then towards the stem.

There are various other conditions which, though not so indispensable as air, heat, and moisture, yet aid this process very much; and of these there is none more important than darkness, to obtain which, along with other advantages, seeds are usually, by harrowing and other means, buried in the soil. Those which are new also germinate more readily than those which are comparatively old, because they are more full of juice, and more readily pass into a state of fermentation. It is often observed, however, that seeds which germinate freely are by no means those which produce the greatest quantities of fruit; on the other hand, they are apt to run into an excessive luxuriance of leaf and stem.

If seeds are sown as soon as they are gathered, they generally vegetate, at the latest, in the ensuing spring; but if they are dried first, it often happens that they will lie a whole year or more in the ground without being altered. This character varies extremely in different species; the power of preserving their vitality is also extremely variable; some will retain their germinating powers many years, in any latitude, and under almost any circumstances. Many plants will come up from soil newly brought to the surface of the earth, in places in which they had not been previously known to grow in the memory of man. Many of the rarest plants in our gardens have been raised from old seeds taken off specimens in herbaria; and others, we have seen, perish so soon that a few days' exposure is sufficient to destroy them.

The earliest indication of germination consists in the parts of the seed swelling, in consequence of the absorption of water by the cuticle, and a chemical change taking place in the nature of its juices. This is said to depend upon a loss of carbon, and an addition of oxygen, without which latter in abundance seeds cannot germinate at all. It is this which causes the starch of barley to be converted into sugar in the process of malting. As soon as these chemical changes have taken effect, the embryo swells and bursts its envelopes, protruding its radicle, which pierces the earth, deriving its support at first from the cotyledons or albumen, but subsequently absorbing nutriment from the earth, and communicating it upwards to the young plant. The annexed figure represents a grain of wheat considerably advanced in germination. The blade is seen bursting the sheath which previously enclosed it. The mass of the grain, now much diminished in consequence of having spent itself in the nourishment of the little plant, and the cotyledon, are still seen on the one hand, and a knob or tuber from which another stem will spring, on the other. Beneath are five radicles, which, like the stem, have burst the sheats in which they were first enveloped.

Fig. 53.



The succeeding figures represent different modes of germination in decotyledonous plants. *Fig.* 54, is the pine in which the seed lobes are so deeply divided as to present the appearance of many in number; *Fig.* 55, is the beech tree in which the cotyledons rise above the surface of the ground, become green, and become seed-leaves, commonly so called. The remaining figure is that of the pea,

Fig. 54.

Fig. 55.

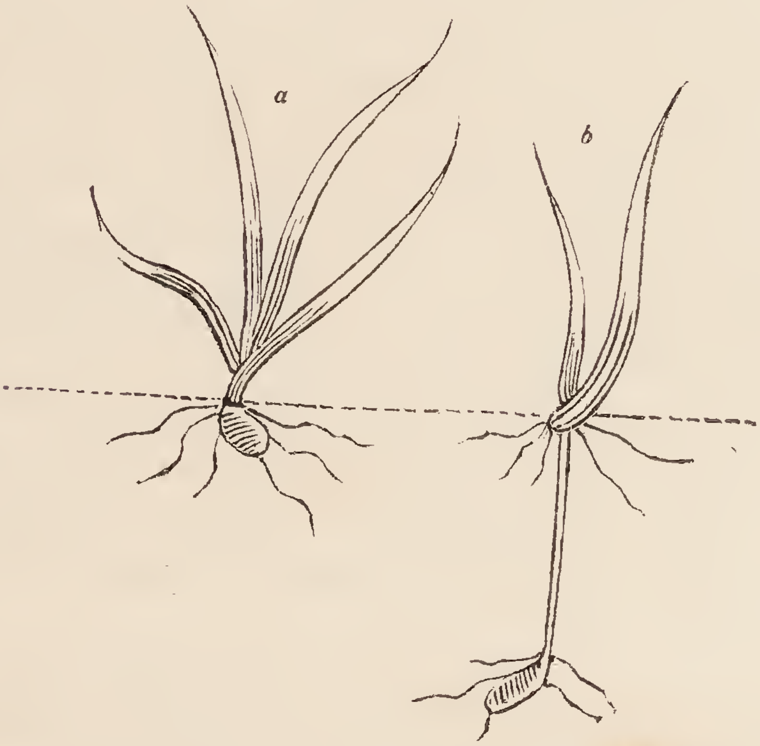
Fig. 56.

which also consists of two cotyledons, which do not, however, rise above the surface of the ground.

It is thus seen that the circumstances under which germination takes place are when the seeds are so situated as to be within the reach of air, heat, and moisture, and are secluded from light. Keeping these in view, the due depth at which they should be deposited in the soil is more easily ascertained. If placed at such a depth in the earth as to be deprived of the influence of the air, and though they may be surrounded by the requisite degrees of heat and moisture, they will, nevertheless, remain dormant. If seeds are diffused over the surface of the ground, they will remain uninjured and unaltered so long as the air is perfectly dry; but, in moist air, germination commences, and the point of the root will be quickly protruded, and find its way into the soil. This is the ordinary process of nature; but experience has taught us that, though grain and other seeds are naturally distributed on the surface around the place where they have been produced, yet there is a proper depth at which all seeds should be deposited, and which is specially suitable. This depth is obviously that which, while it affords the necessary degree of heat and moisture, is within the requisite influence of the air.

Seeds will vegetate in a moist atmosphere, when placed upon the surface of the ground, and experience has repeatedly confirmed the fact, that the same process will take place even should they be too deeply covered. It does not, however, follow that the depth at which they are placed is unimportant. An undue covering is indeed highly detrimental, and opposed to the processes of nature. An example of this may be seen in *Fig.* 57, in the case of the cereal gramina, showing

Fig. 57.



the effect of too deep covering over the seed; and the same holds good, in a greater or less degree, in the case of all the cultivated plants. The dotted line is the surface of the ground; *a* represents a healthy plant of wheat from seed deposited at the proper depth; and *b* the growth of a plant from seed too deeply covered. The latter, it will be observed, vegetated although placed at an undue depth below the surface, threw out its seminal roots, and sent up its first shoots, bearing two leaves, into the air; but as the growth of the culm rises therewith, and remains near the surface, it also throws out roots, and entirely supersedes those which were first produced in the grain. This is a provision of nature to accommodate herself to circumstances of accidental position in the seed.

In order to insure the deposition of the seed to the proper depth, and that it be placed in circumstances otherwise favourable to its growth, the proper cultivation of the soil is of the first importance. Minute pulverization is necessary, to admit of the access of air; and drainage is indispensable to remove superfluous moisture, which would otherwise greatly injure or altogether destroy the seed. The mode of sowing also exercises an important influence in this respect. According to the drill system, the seeds are placed at a more uniform depth, than when scattered promiscuously over the surface ; and it is therefore to be preferred in every case in which it is expedient.

After the nourishment contained in the seed has been expended in the development of the little plant, the root is more or less able to draw nourishment from the soil, and the stem to vegetate. This, however, is often a very critical period in the life of the individual, and may generally be detected by the sickly aspect of the young plant, or braird. It seems either to be left, for a time, without a sufficient supply of nourishment, or the new kind of nourishment which it begins to draw from the soil is not, at first, so congenial to its nature, as that from which it has just been weaned. This may be looked upon as a constitutional disease, to which we find so many species of plants are subject ; but it is to be regarded as a wise provision for carrying off sickly and degenerate individuals, that the race may be preserved and propagated in a state of the most healthy development.

Seeing, then, the great influence which the quality of the seed exercises over that of the plant produced from it, it might seem unnecessary to recommend the utility of procuring that only which is of good quality, and free from any admixture of the seeds of other plants. The practice of farmers, however, is often directly opposite to this mode of procedure, very little discrimination being used in the selection of seeds, either as to its being of good quality, or being free from admixture of the seeds of weeds. The difference in price between seed of the best quality, and that of an inferior description, is so inconsiderable, that the farmer never should hesitate a moment which he should choose, when the value of the produce of his crop is at stake.

In the choice of seed, regard must be had to procure it from a suitable soil and climate, as well as of a proper variety. A change of seed is in general to be recommended, as founded on rational principles. Every plant has a peculiar soil and climate suited to it, where it flourishes and grows to perfection without showing symptoms of degeneracy. When the plant is indigenous, seed dropping from it arrives at perfection, without any change ; but when it is exotic, it has a tendency to degenerate in a great degree, if the seed be sown, year after year, where it was produced.

Besides preventing degeneracy in the quality of the produce, the crops of the farmer, by a judicious change of seed, will sooner reach maturity, an object in many cases of the greatest moment. It is well known that a change of constitution in plants, originating from the situation in which they have been produced, is commonly transmitted to their offspring. Thus, plants propagated from seed produced in a warm sandy soil, will have a tendency to early maturity in whatever situation the seed is sown, through a number of successive generations; and plants from seed produced on a cold stiff soil, will have their habits of ripening changed in a corresponding degree. A change of seed is also more necessary in the case of some of the cultivated plants than in others. This often arises from some peculiarity in the soil, as well as from the habits of the plant.

The quantity of seed which should be sown depends on the species of plant cultivated, and numerous other considerations. Rich soils require a smaller portion of seeds than poor soils, as the seeds have, in the former case, a better chance of vegetating, and the plants, becoming more luxuriant, occupy individually a greater space. In determining the proper quantity of seed, regard must be had as to whether the season of sowing is favourable or not for the operation, as, in unfavourable seasons, part of the seed is placed in circumstances in which germination does not freely take place, and it is consequently lost. The quality of the seed itself, and the mode of sowing, are also to be taken into consideration, as influencing the quantity to be sown.

In general a liberal allowance of seed is to be recommended, as a full crop of any description is cheaply purchased by giving a sufficiency of seed. There is a happy medium, however, in this, as in every thing else; for the crop may not succeed when the plants are too numerous in the ground, any more than when they are too few. Their own luxuriance may likewise be prejudicial, by retarding their ripening, and thereby hazarding the value of the crop.

Having given a brief outline of the structure of seeds, and the phenomena attending the process of germination, we now proceed to a description of the general structure of plants, so far as their nature and habits can be modified by the cultivator. In the execution of this department of the subject we shall begin with the root, and proceed successively to the stem, leaves, flower and fruit. This arrangement, however, is adopted more in accordance with established usage than from a conviction that it is the most eligible in a scientific point of view. To seek for such a one in our present circumstances, would indeed be a waste of labour; as from the intimate connexion and dependance upon each other of the different parts of the vegetable structure, no one can be treated of without ambiguity, unless reference be made to the connexion subsisting between it and the other parts of the plant. But before entering on a description of the several parts of which plants are composed, it may be proper to take a brief survey of their general structure.

Plants are said to be organized bodies, because they have a structure quite different from that of inorganic substances; a structure made up of cells, fibres, tubes, and membranes, which join together to form distinct parts and organs. Some have endeavoured to trace this structure to certain primitive forms, existing in the rudest beginnings of vegetables, as well as in all parts of perfect plants. When vegetable matter is examined by the aid of a microscope, we discover more or less of these forms. In the lowest organic bodies, both of the animal and vegetable kingdoms, we find by the aid of a powerful magnifier, a spherical structure intermixed with spiculi or threads, in the fluids or solids composing their parts. The simplest plants as well as the infusory animalculus have this structure.

The great simplicity of the vegetable structure, compared with the complexity of that of the more perfect formed animals, is very remarkable; and whilst every separate function performed by the latter seems to require an organ of a peculiar construction, the functions of vegetation are all carried on by the intervention of a few simple tissues of the same kind.

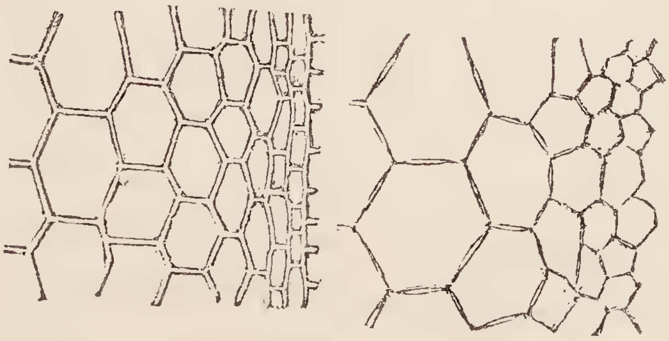
II.—ELEMENTARY ORGANS.

If plants are considered with reference to their internal organization, they appear, at first sight, to consist of an assemblage of exceedingly minute cavities, separated by a membranous substance; more exactly examined, it is found that these cavities have a variety of different figures, and that each is closed up from those that surround it; and if the inquiry be carried still further, it will be discovered that the partitions between the cavities are all double, and that by maceration in water, or by other processes, the cavities with their enclosing membrane may be separated from each other into distinct, bodies. These bodies constitute what is called the *vegetable tissue or elementary organs.*

The primitive solid components of the vegetable textures are membrane and fibre, from which are formed the common organic structures, the cellular and the vascular tissues,* and the varied combinations of these in the bark, wood, pith, and medullary rays. The fluid elements are watery solutions of the soluble materials of the soil; from the decomposition of which, and the recombination of their ultimate components, by means of the mechanical and chemical agency, influenced by the principle of life, all the solid components, textures, and secretions, are formed.

Cellular tissue generally consists of little bladders or vessels of various figures, adhering together in a mass. If a thin slice of the pith of elder or any other plant be examined with a microscope, it will be found to have a sort of honeycomb appearance, as if there were a number of hexagonal cavities separated by partitions. These little cavities are the inside of cellules of cellular tissue; and the partitions are caused by the cohesion of their sides, as may be easily proved by boiling the pith a short time, when the cellules readily separate from each other. In pulpy fruits, or in those which have their cellular tissue in a loose, dry state, when ripe, the cellules may be readily separated from each other without boiling.

Fig. 58.



Cellular tissue is always transparent and colourless, or at most only slightly tinged with green. The brilliant colours of vegetable mat-

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[*] *Tissue*, a web, is the name applied to the soft and flexible parts of animals and plants; the *cellular tissue* is divided into cells, the *vascular* into vessels.

ter, the white, blue, yellow, scarlet, and other hues of the corolla, and the green of the bark and leaves, are not owing to any difference in the colour of the cellules, but to colouring matter of different kinds which they contain. The colouring matter of the cellular tissue is frequently fluid, but in the leaves, and some other parts, it is more commonly composed of granules of various sizes. This is particularly the case in all green plants, in which the granules lie amongst greenish liquid, the latter of which, as they grow older, dries up, while the granules themselves gradually change to olive green, and finally to brown.

The cellules of cellular tissue are usually very small, but they are exceedingly variable in size. The largest are generally found in the gourd tribe, or in pith, or in aquatic plants; and of these some are as much as the thirtieth of an inch in diameter, while the ordinary size is about the four hundredth, or the five-hundredth part of an inch, and it is sometimes not more than the one-thousandth.

Cellular tissue is supposed to be capable of performing, by itself, all the more important of the vital actions of vegetation; because there are many plants which live, grow, and propagate themselves, without possessing any other kind of tissue.* When combined with other forms, it has, however, certain objects in particular, for which it is destined. One of its most important functions is to absorb moisture or gaseous matter, and to part with it again, acting as a sort of filter. If a slice of the pith of elder be placed upon a piece of glass, and allowed to communicate by ever so small a space with water, the whole mass will be speedily saturated; and on the other hand, it will as readily part with its moisture when exposed to a dry atmosphere; not always, however, for in some cases, such as succulent plants, it parts with water very slowly. It is found that the moisture evaporates through its membranous sides, which are therefore eminently hygrometrical; and as they permit water to pass through them readily, they may be supposed to contain perforations, but they are so small that the most powerful microscopes have failed to detect them.

In the case of wounds, or even of the development of new parts, cellular tissue is first generated: for example, the granulations that first form at the extremity of a cutting when first imbedded in earth, or on the edges of incisions in the wood or bark; the extremities of young roots; scales, which are generally the commencement of leaves; pith, which is the first part formed when the stem shoots up; nascent stamens and pistils; and finally, many rudimentary plants; all these are, at first, or constantly, formed of cellular tissue alone.

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* This is exemplified in the case of the Algæ and Fungi, and other Cryptogamic plants, which are accordingly termed *Cellulares*.

It may, in fact, be considered as the flesh of vegetable bodies; the matter, which surrounds and keeps in their place all the ramifications or divisions of the vascular system, is cellular tissue. It is, moreover, the grand agent, by means of which many of what may be called the mechanical forces of plants are excited. If, for instance, there are two parts to be torn asunder by contraction, as in the valves of the anther, it is by the shrinking of cellular tissue that it is effected; or, if one part is to be burst by the swelling of another, it is to the same kind of tissue that this office is entrusted by nature. In fine, it is the most delicate, the most coarse, the most universal, the most pliable, and the most energetic of the elementary organs of vegetables.

Woody fibre consists of very slender, transparent, membranous tubes, tapering acutely to each end, lying in bundles, and, like the cellular tissue, having no direct communication with each other, except by invisible pores. It constitutes a considerable proportion of the ligneous parts of all plants; it is common in bark, and it forms the principal portion of the veins of leaves, to which it gives stiffness and tenacity.

It would appear, that the action of this part of the elementary organs of plants is merely the conveyance of fluid upwards or downwards, from one end of a body to another, and for giving firmness and elasticity to every part.

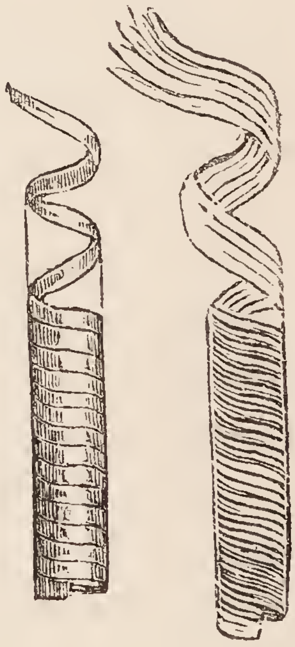
That it is intended for the conveyance of fluid may be inferred from the circumstance of its constituting a principal part of all wood, particularly of that which is formed in stems the last in each year, and in which fluid first ascends in the ensuing season; from its presence in the veins of leaves, when a rapid circulation is known to take place; and from its passing downwards from the leaves into the bark, thus forming a passage through which the peculiar secretions may, when, elaborated, arrive at the stations where they are finally to be deposited.

With regard to its giving firmness and elasticity to the vegetable structure, we need only consider its surprising tenacity, as evinced in hemp, flax, and the like; and its constantly surrounding and protecting the vascular system, which has no firmness or tenacity itself. The extremely slender tubes of which it is composed possess, separately, but a very slight degree of strength; but, being of different lengths, tapering to each extremity, and overlapping each other in various degrees, these are consolidated into a mass, which a considerable force is insufficient to break.

Vascular tissue consists of simple membranous tubes, tapering to each end, but often ending abruptly, either having a fibre generally spiral in their inside, or having their walls marked by dots, or transverse bars, arranged in a spiral direction. Of vascular tissue there are two principal kinds, spiral vessels and ducts.

The *spiral vessels* are membranous tubes, on the inner surfaces of which a cylindrical fibre is spirally coiled, and the whole so completely united, that if the vessel be ruptured and the thread uncoiled, no trace of the membrane is to be seen, excepting towards the conical extremity of the vessel, when the coils of the fibre are wider apart. In some cases, indeed, the successive coils are not in contact with each other, and then the investing membrane is sufficiently apparent. Sometimes the fibre branches into two threads, and each continues its course in separate but continuous coils; and instances may be found where the continuous coils of separate threads amount to upwards of twenty in number. The diameters of these vessels vary from the three thousandth, up to the three hundredth part of an inch. If the root of the common garden lettuce is partly cut across, and the remainder broken gently asunder, the spiral vessels will most generally be discernible. They may also be found in the leaf stalk of the common artichoke, when young and fresh, in the fibres of which they are not only remarkably large and distinct, but also remarkably beautiful, some of them exhibiting in their natural position the appearance of spiral coats, investing interior fibres, rather than that of forming a distinct tube, and seeming, when uncoiled, to be themselves formed of a sort of net work membrane. In the leaf stalk

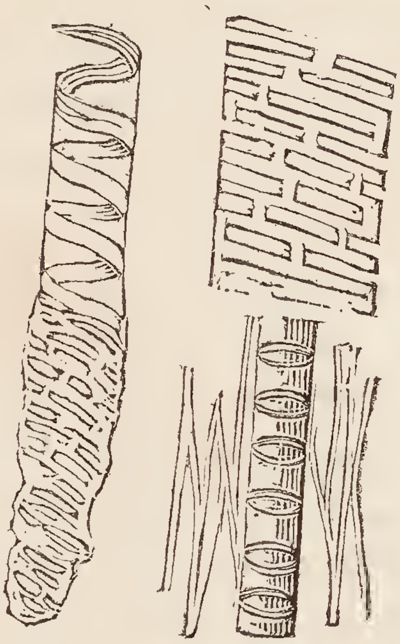
Fig. 59.



of the strawberry, they may be also found, on pulling it asunder when they unroll, and appear to the naked eye like a fine cobweb.

Very different opinions have been entertained as to the exact structure of the spiral vessels, but they cannot be noticed here. With the exception of the bark, they are met with in every part of vascular plants—in the wood, in the leaves, and in the petals of flowers. They are more abundant in some species than in other, and in different plants they are most abundant in some peculiar parts Except in some particular plants, they are not found in the root, and they are also of comparatively rare occurrence in wood.

Fig. 60.



Ducts are membranous tubes, with conical or rounded extremities; their sides being marked with transverse lines, or rings, or bars, or dots, arranged spirally, and being incapable of unrolling. They have a great resemblance to spiral vessels, and are probably a mere modification of them, being chiefly distinguished by their want of elasticity, and of the power of unrolling. Botanists enumerate several varieties of these organs. *Fig.* 60 represents the appearance presented by some of them when highly magnified. The name of ducts is generally given to all varieties of tubes composing the vascular tissue, which are not, strictly speaking, true spiral vessels; and they are separately named according to the appearances, which the markings on their surface assume; such as dotted, striped, and reticulated ducts.

The real nature of the functions of the vascular system has been the subject of great difference of opinion, and may, indeed, be said to be so still. Spiral vessels have been supposed to be destined for the conveyance of air; and, latterly, it has been asserted that they serve for the transmission of fluids upwards from the roots. But it is probable, that both these functions are sometimes performed through the agency of the vascular system; however, the subject is as yet involved in much obscurity, and it would be altogether inconsistent with the nature of this work to enter into any detail of the various theories that have been proposed.

Having now explained the more important circumstances connected with modifications in the elementary organs of vegetation, the next subject of inquiry will be the manner in which they are combined into those masses which constitute the external or compound organs; or, in other words, the parts that present themselves to us under the form of roots, stems, leaves, flowers, and fruit; and that constitute the apparatus through which all the actions of vegetable life are performed.

When a plant first begins to grow from seed, it is a little body, called an embryo, with two opposite extremities, of which the one elongates in the direction of the earth's centre, and the other, taking a direction exactly the contrary, extends upwards into the air. This disposition to develope in two diametrically opposite directions is found in all seeds, properly so called, there being no known exception to it; and the tendency is, moreover, so powerful, that no external influence is sufficient to overcome it. The result of this development is the axis, or centre, round which the leaves and other appendages are arranged. That part of the axis which forces its way downwards, constantly avoiding light, and withdrawing from the influence of the air, is the descending axis, or the root; and that which seeks the light, always striving to expose itself to the air, and expanding itself to the solar rays, is the ascending axis, or the stem.

III.—THE ROOT.

The root is seen to be that part of the plant by which it is fixed in the soil, and by which nourishment enters it to be transmitted upwards into the stem and leaves.

In common with every other part of the vegetable structure, a great diversity of form is exemplified in the development of roots, to which different terms are applied by the botanist; but a detailed account of these would not be interesting to the general reader. According to the ordinary laws of vegetable development, plants of the same species are furnished with the same kind of roots, not producing, at one time, woody or fibrous roots, and, at another time, bulbous roots; and yet it is found, that there are cases in which changes of this kind do occur. When part of the root of a tree, planted by a pond or river, protrudes beyond the bank, so as to be partially immersed, it divides at the extremity into innumerable fibres from the surface, which become again subdivided into fibres still more minute. The root of the *Phleum pratense*, when growing in a moist soil, which it naturally affects, is uniformly fibrous; but when growing in a dry soil, where it is also often found, it is furnished with a bulbous root; and the same is the case with some other plants. This generally seems to be merely the result of a provision of nature, by which the plant is endowed with the capacity of collecting a supply of nourishment suited to existing circumstances, and, hence, of adapting itself to the soil in which it grows.

The root, then, fulfils an important function in the vegetable economy, being the part through the instrumentality of which nourishment is conveyed to the plant. But what gives roots their chief value to the agriculturist is, that, besides being the apparatus by which the plant is fixed in the ground and nourished, they are also capable of becoming reservoirs of nutritious matter, which, though designed for the subsequent use of the plant, is profitably appropriated to the support of the domestic animals of the farm.

It does not appear that sap is fit for nourishing a plant until it has been elaborated in the leaves; but it frequently happens, that more can be elaborated by them at one time than is necessary for the immediate consumption of the plant, in which case, it is conveyed back, and stored up for future use, at a period when the leaves, not being in a state of activity, or the soil being exhausted, there is some obstacle to the immediate formation of nutrient matter. In perennial plants which form buds, this nutrient matter is usually deposited in the cellular tissue, about their roots or origin, and yields sago and other nutritious articles of diet. When the plant is of that more perfect kind, where many buds are formed, and the stem contains what is properly called pith, in it the nutrient juices are stored, to be carried in another season to the unevolved bud by the ascending sap.

But although trees, shrubs, and many forms of plants, admit of this supplementary nutriment being deposited in stores at the base of the buds, and though the palms and the plants which yield sago admit of its being formed in one great mass, at elevations in the atmosphere, many other plants are of such a structure as to admit of its being deposited only near the ground, or in what is commonly called the root; and it is for the sake of this reservoir of nourishment, that the farmer cultivates many crops in his fields. Of this kind are the turnip, carrot, parsnip, beet, and other plants, which have their foliage growing out of the mass of their roots, and are cultivated for the supply of nourishment, which they store up for the fructifying season.

It will be at once seen how much the value of such a crop depends on its obtaining a plentiful supply of nourishment from the soil; and, since this supplementary nutriment is not deposited until it has undergone that peculiar change in the leaves already referred to, it is also evident how conducive a healthy tillage, warmth, sunshine, and whatever is necessary to their healthy action, are to the formation of a good root. The same view enables us to understand the loss in value which a root sustains when the plant is allowed to run to seed. The nourishment is stored up chiefly for consumption at this critical period, when an exhausted soil and an advanced season seem to render precarious the accomplishment of that object which nature is, at all times, bent to perform before the extinction of the individual. By this beautiful provision, however, the process of fructification goes on almost independent of accidental circumstances, and even though the plant be torn out of the soil; but when the important object has been completed, the root is deprived of that mass of nutriment which it previously contained, and a hard fibrous substance only remains behind.

It has been said, that, in trees, the superabundant nutriment is deposited in the pith, at the base of the buds; in some plants the buds are produced underground, and the nutriment is conveyed down to them there. This takes place in the case of the potato. The tubers of this plant, and the fibres by which they are attached to the base of the stem, are to be regarded as belonging to a very different class of organs from the roots of the plant, though their subterranean situation commonly obtains from them that name. The tuber of the potato, unlike a root, does not contribute to the nourishment, but rather to the exhaustion of the then existing plant. It is to be regarded rather as a reservoir of nutrient matter, destined to serve for the development of the future plants, until they have pushed forth roots into the soil, and its office is to produce a plant next year.

On examining a thin slice of a potato under the microscope, its structure is beautifully seen. It will be found to be composed of different layers, of which the external one is often highly coloured, and contains a certain portion of a deleterious substance, which is found in most plants of the natural family to which it belongs. But the great mass of the tuber is composed of a substance, occupying the place and possessing the structure of the pith of a young branch. Under the microscope, it is seen to be almost entirely composed of cells of irregular form and size, containing clusters of beautiful little oval grains, translucent, and of a pearly lustre. These little grains remain unchanged in cold water, but when it is heated to about the degree that wax melts, they dissolve in it, and the whole becomes a jelly, and occupies a larger space than it did before. When a potato is boiled, then, each of the almost innumerable cells of which it is composed becomes a little vessel full of jelly; and if there be not a great quantity of starch in the cells it may be gelatinized without bursting them. But if the number of grains, or their size, be very great, the cellular structure of the potato is ruptured on all sides by the expansion of the little masses of jelly, and the appearance of mealiness is produced. Hence we see, that mealy potatoes are the most valuable, and waxiness is an indication of a deficiency of starch, or nutritive matter.

It will be perceived, from what has been said of the structure and functions of the potato, which applies to tubers generally, that there is a strong resemblance between them and seeds. But, independently of others, there is this very marked difference, which it is important for the cultivator to notice, that a tuber, as a potato, produces an individual resembling its parent in all its features, in kind and quality. The tuber keeps up the particular variety which produced it, and may be regarded as a continuance of the individual; while the seed has a constant tendency to destroy all varieties, and bring back the plant to the natural form and characters of the species. Thus, by planting a potato, we can predict with certainty the kind which we shall dig from our field; but, by sowing the seeds, we could not foretel what particular variety they may produce.

There is another distinction which may be noticed. It is well known, that the quantity of seed may sometimes be increased by lopping off the excessively luxuriant herbage. When plants are furnished with an abundant supply of food, their reproductive energies develope themselves slowly, and flowers and fruit, or seeds, are late in appearing. On the other hand, when the supply of nourishment is scanty, when the plant is, as it were, starved, and when death is threatened, the reproductive energies act with readiness, flowers and seeds are produced, and the extinction of the race guarded against. In the cultivation of the farm, numerous examples of this arrangement are constantly occurring. The crops growing on the most inferior soil are always the first to exhibit their flowers, and arrive at maturity. But the case is different in reference to bulbous and tuberous roots generally, for it is only after having been elaborated in the foliage, that the sap returns to the root ; and, if the foliage be destroyed, or its functions impeded by disease, the root suffers in the same proportion.*

The roots of plants vary greatly in their external characters, as well as in their economic value ; and this variation is still further increased by cultivation. Those plants which are cultivated chiefly for their roots, the leaves being merely a secondary consideration, are very different from the original species from which they were derived, so far, indeed, that in their unimproved state they cannot be regarded as beneficial objects of culture. Thus far we have chiefly confined our attention to the consideration of this class of roots, but fibrous roots are also deserving of notice ; for although they are of themselves of little value, yet they perform the same important office in the vegetable economy, namely, that of deriving the nourishment which supports the growing plant from the soil.

Fibrous-rooted plants comprise a very considerable proportion of the cultivated produce of the farm, as all those plants usually termed gramineous belong to this class. These roots consist of a number of small fibres, having their origin at the base of the stem, being generally situated near the surface of the ground, and seldom penetrating to any considerable depth. In some cases they are composed of two sets of roots, or fibres, the one proceeding from the seed, and, being deeper placed in the soil, seems chiefly intended for giving the plant a sufficient hold of the ground ; and the other, springing from the first joint which is formed near the surface, and being seldom found far below it, seems destined for supplying the plant with nourishment. The former are called seminal, and the latter coronal roots.

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* Quarterly Journal of Agriculture, vol. i.

Besides the economic value of roots, it has been seen that they serve as the means of attachment of plants to the soil, and to draw from them a portion of the juices necessary for the support of vegetable life. The roots of many plants, however, appear to perform only the first of these functions. This is chiefly remarkable in thick succulent plants, which absorb from the air the substances necessary for their nutrition at all points of their surface; in this case the roots serve simply to fix the plants in the soil. The magnificent *Cactus Peruvianus* growing in the hot house of the Museum of Natural History at Paris, is of an extraordinary height, and sends out its large branches with extreme vigour, and often with amazing rapidity; yet its roots are contained in a box which barely contains four cubic feet of earth, which is never renewed or watered. Neither are the roots of plants always in proportion to the size or strength of the trunks which they support. The tribe of palms and pines, whose trunk sometimes reach the height of an hundred feet and upwards, have very short roots, which do not extend far in the ground, and attach themselves but feebly to it. On the contrary, herbaceous plants, whose weak and tender stems die yearly, have sometimes roots of great length and size compared with the stem, as is the case in the liquorice, lucern, and the common weed called rest-harrow.

Notwithstanding the striking cases which have been mentioned, roots in general extract from the earth the substances which contribute to the growth of the plant. All parts of the root, however, do not perform this office, it being only by the extremities of the small fibres, that absorption is accomplished. It has been found that their extremities are terminated by little spongy bodies, or *spongioles*, with porous absorbing mouths. If we take a radish or turnip, and immerse in water the small root by which the bulb is terminated, it will vegetate and shoot forth leaves. The roots of certain plants appear to excrete a peculiar matter which varies in the different species. Thus, unctuous fatty matter has been found about the roots of the elm, which was supposed to have been excreted from the roots of that tree. To this matter, which varies, as it has been said, in different species of plants, the sympathies and antipathies which certain vegetables have for each other is no doubt to be attributed. Hence the well-known fact, that certain vegetables will not thrive if successively planted in the same soil.

From the view of the structure and functions of the roots of plants now given, some practical inferences may be derived by the cultivator. Efficient tillage, performed to a considerable depth, and the application of large quantities of manure, will be seen to be indispensable in the case of plants cultivated for their roots and tubers, or such as are not required to ripen their seeds; while in the case of fibrous-rooted plants, the seeds of which form the chief inducements to their culture, an over-supply of manure will entirely frustrate the object in view, as the foliage will thereby become so luxuriant as to prevent the plants from bringing their seeds to maturity.

IV.—THE STEM.

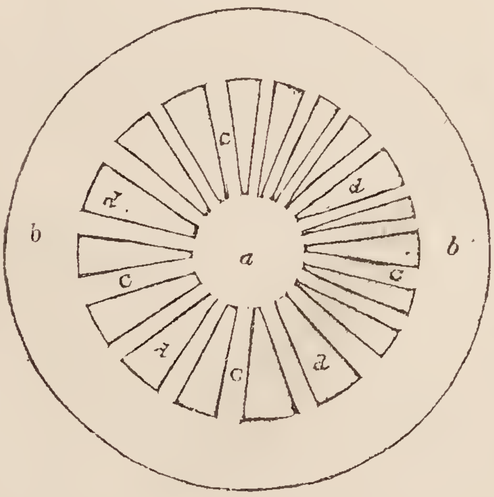
Where the stem and root, or the ascending and decending axes, diverge, there commences, in many plants, a difference of anatomical structure, and in all, a very essential physiological dissimilarity. This portion of the axis is called the neck or collum, and has been thought by some to be the seat of vegetable vitality,—an idea which is now well known to be erroneous. At first, it is a space which we have no difficulty in distinguishing, so long as the embryo, or young plant, has not undergone any considerable change, but, in process of time, it is externally obliterated, so that, in trees of a few years' growth, its existence becomes a matter of theory, instead of being actually evident to our senses.

In the case of some of the cultivated agricultural plants, the stem is not put forth until the second year of their growth; the foliage during the first year being composed of radical leaves, or such as spring immediately from the root. It has been seen, that during the first stage of the growth of these plants, the whole supply of nutriment is stored up in the root, there to be retained until the flower-stem should arise, for the evolution and support of which it was destined. The farmer then takes advantage of this property, and sows the crops cultivated for their roots at such a period of the season, that the growth of the roots shall be just completed by the time the winter sets in, this being the period in which they are usually consumed by the domestic animals of the farm. If sown too soon, their flower-stems are usually evolved before the end of the season, to the great deterioration of the root.

The stems of flowering plants are conveniently arranged into two classes, differing essentially in their nature, according as they spring from dicotyledonous or monocotyledonous seeds. The former are well illustrated by such plants as the oak, a transverse section of which exhibits a central cellular substance, or *pith*, an external cellular and fibrous ring, or *bark*, an intermediate woody mass, and certain fine lines radiating from the pith to the bark, through the wood, which are called the *medullary rays;* and this is termed the *Exogenous structure.* In the latter, of which the cane is an example, on the contrary, neither bark, pith, wood nor medullary rays are distinguishable ; the tranverse section exhibits merely a large number of hard spots, caused by the section of bundles of woody tissue, and a mass of cellular substance in which they lie imbedded. This kind of structure is said to be *Endogenous.*

In both cases there is a cellular and a vascular system distinct from each other, by a diversity in the respective arrangement of which the differences above described are caused. The succeeding remarks apply chiefly to the stems of trees, as they have been more accurately examined, and show the different processes of the vegetable development in a more perfect manner.

Fig. 61.



The cellular system in an exogenous stem chiefly occupies the centre and the circumference, which are connected by thin vertical plates of the same nature as themselves. In the annexed diagram, representing a section of an exogenous stem, *a* is the pith, the circumference, *b*, is the bark, and the connecting vertical plates, *c*, are the medullary rays.

The *pith* is the loose spongy substance formed almost entirely of cellular tissue, which occupies the centre of the stems, commencing at its lower extremity, and terminating at the leaf buds. A few vessels seem to run through it in the longitudinal direction. Its cellules are generally very regular. Like those of the cellular tissue in other parts, they all communicate with each other. Sometimes, and especially in young branches and herbaceous plants, the cellular tissue of the pith is abundantly supplied with fluids, and filled with granulations of a green colour, as may be seen on breaking a branch of elder, one year old, in which the pith presents the appearance of a green and very moist fleshy body. It communicates with the cellular and herbaceous layer of the bark by means of peculiar prolongations which it sends through the wood, which are the medullary rays before mentioned.

The *bark* presents a structure resembling that of the wood, but the phenomena are presented in a reverse order. It consists of a number of layers, the outermost of which is called the *epidermis*, which is common to all organized beings both of the vegetable and animal kingdom. It is a thin, nearly transparent layer, formed of a uniform tissue, which appears composed of cellules varying extremely in form, and presenting numerous small openings or pores. The epidermis envelopes all parts of the vegetable ; but it is more especially apparent in young stems, from which it may easily be separated with a little caution. It possesses only a certain degree of extensibility, and when stretched beyond this point, by the enlargement of the trunk, it tears and splits, as is observed in the oak and the elm, or it is detached in flakes or plates, as in the birch and plane. When removed from a young stem it is replaced without difficulty. The colour which it presents is not inherent in its nature, but is derived from the peculiar colouring of the tissue on which it is applied. Hence the green colour so prevalent in the leaf and tender shoot, which the transparent epidermis merely transmits, and the beautiful variety of lines displayed in flowers and fruit.

Under the epidermis is observed a layer of cellular tissue, connecting the former with the cortical layers, and termed the *herbaceous envelope.* Its colour is generally green in young stems. It covers the trunk, the branches, and their divisions, and fills up the spaces which exist between the ramifications of the nerves of the leaves. To this the term *outer medulla* has lately been applied by botanists, in opposition to *inner medulla*, a term applied to the pith. Its colour is not derived from the cellular tissue of which it is composed, but is owing to the matter contained in it. When this herbaceous envelope acquires great thickness and peculiar physical qualities, it constitutes the part known by the name of cork in the cork tree, and some other plants. It is through the agency of this substance that the decomposition of carbonic acid from the atmosphere is effected, and oxygen given out,—one of the most remarkable chemical phenomena which vegetable life presents.

The *liber* or *inner bark* lies immediately in contact with the *alburnum*, or first circle of woody fibre. It is composed of a vascular network, the elongated meshes of which are filled with cellular tissue. Like all other parts of the bark, it is capable of being replaced when it has been removed; but before it can be reproduced, the part from which it has been detached must be guarded from the contact of air. In this case a viscid substance is seen to exude from the surface of the woody body, which, spreading over the wound, acquires consistence, becomes green and cellular, and reproduces the portion of liber which has been removed. To this viscid substance the term *cambium* is applied by botanists.

When highly magnified, the cambium is found to consist of numerous minute transparent granules, and to exhibit faint traces of a delicate cellular organization. This is the elaborated sap of the plant, by means of which a layer is annually added to the stem.

The cellular system of the pith and that of the bark are, in the embryo and youngest shoots, in contact; but the vascular system, as it forms, gradually interposes between them, until they are distinctly separated, and, in aged trunks, are sometimes divided by a space of several feet; that is to say, by half the diameter of the wood. But whatever may be the distance between them, a horizontal communication of the most perfect kind continues to be maintained. When the vascular system is first insinuated into the cellular system, dividing the pith and bark, it does not completely separate them, but pushes aside a quantity of cellular tissue, pressing it tightly into thin radiating plates; and as the vascular system extends, these plates increase outwardly, continuing to maintain the connexion between the centre and circumference. These are the *medullary rays*. In horizontal sections of an exogenous stem, they are seen as fine lines radiating from the centre to the circumference; in longitudinal sections they give that glancing satiny lustre which is in all discoverable, and which gives to some, as the plane and sycamore, a character of remarkable beauty.

The office of these processes is very important. They are the great means of communication between the circumference and centre of the stem, and they enable the fluid matter which passes down the bark to reach the wood next the pith. To qualify them for performing this office, their component parts are placed with their longer diameter perpendicular to the bark; a position the most favourable that vegetable tissue could assume under such circumstances, to perform the necessary functions. When examined under a microscope, the component parts of the medullary rays resemble bricks placed across the fibres of the wood.

The vascular system in an exogenous stem is confined to the space between the pith and the bark, where it chiefly consists of ducts and woody fibre, collected into compact wedge-shaped vertical plates, as seen, *d*, *Fig.* 54, the edges of which rest upon the pith and bark, and the sides of which are in contact with the medullary rays.

That portion of the vascular system which is first generated is in immediate contact with the pith, to which it forms a complete sheath, interrupted only by the passage of the medullary rays through it. It consists of spiral vessels and woody fibre intermixed, and forms an exceedingly thin layer, called the *medullary sheath.* This is the only part of the vascular system of the stem in which spiral vessels are ordinarily found, the whole of the vessels subsequently deposited over the medullary sheath being ducts. The medullary sheath establishes a connexion between the axis and all its appendages; the veins of leaves, flowers and fruit, being in all cases prolongations of it.

The vascular system of a stem of one year old consists of a zone of wood lying between the pith and the bark, lined in the inside by the medullary sheath, and separated into wedge-shaped vertical plates by the rays passing through it. This zone is composed of woody fibre, forming a compact mass on the outside, but intermixed with ducts towards the centre of the stem. The second year another zone is formed of a similar structure, and so on, an additional zone being deposited every year as long as the plant continues to live. As each new zone is formed over that of the previous year, the latter undergoes no alteration of structure when once formed; the wood not being subject to distention by a force beneath it, as the bark is, but whatever the first arrangement and direction of its tisssue may be, such they remain. The formation of the wood is, therefore, the reverse of that of the bark, the latter increasing by addition to its inside, and the former by successive deposits upon its outside. It is for this reason that such stems are called *exogenous*, a term signifying to grow outwardly.

As in the case of roots, the wood has two distinct offices to perform. In the first place, it imparts to plants that solidity and toughness which enable them to stand erect in the air, without being destroyed by winds, or crushed by their own weight; and, in the second, it is through the wood exclusively that the nourishment proceeding from the root enters the leaves, for which purpose it has a simple though elaborate apparatus of tubes and vessels. The latter, when young, serve as conduits for fluid matters; and, when old, act as receptacles of the peculiar secretions of trees. In their former state they are nearly colourless, and form a pale mass, to which we apply the term *alburnum*, or sap-wood; when old, and filled with secreted matter, they become dark in the colour, and then are heart-wood, or *duramen*.

The difference in colour between the true wood and the alburnum is very remarkable in trees whose wood is very hard and compact, and especially in those in which it is more or less of a deep colour. Thus in ebony and logwood, the wood, properly so called, is black or deep red, while the layers of alburnum are of a very light greyish tint. But in trees which have white and coarse-grained wood, the difference between the woody layers and alburnum is very slight. A remarkable difference, however, between them is the existence of vessels in the former, while the latter is wholly destitute of them. By means of these vessels the sap is conveyed into the substance of the trunk; but a period arrives when, through the progress of age, the walls of these vessels become thickened, their cavity diminishes, and at length even disappears.

Endogenous stems apparently differ very much from these, for they have no pith, medullary rays, bark, or wood, properly so called; but consist of a confused mass of bundles of woody substance placed in spongy matter. The date, the palm, the cocoa-nut tree, the sugar-cane, and most of the trees of tropical climates, belong to the class of endogenous or monocotyledonous plants.

The diameter of an endogenous stem is increased by the constant addition of fibrous bundles to the centre; whence the name. These bundles displace such as are previously formed, pushing them outwards; so that the centre, being always the part most recently formed, is the softest; and the outside, being older, is the hardest. In endogenous plants having attained a considerable age, this operation goes on until the outside becomes sometimes hard enough to resist the blow of a hatchet. It does not, however, appear that each successive bundle of fibres passes exactly down the centre, or that there is even much regularity in the manner in which they are deposited; it is only certain that it is about the centre that they descend, and that on the outside no new formation takes place.

The endogenous plants of temperate climates are comparatively diminutive in size. In our climate, for instance, the grasses are somewhat remarkable, amongst other species of the vegetable kingdom, for their humble stature, and their inconspicuous appearance; while, in the warmer regions of the globe, the bamboos and canes, which belong to the same natural family, emulate our trees in height and beauty. But what our species want in individual magnitude, is far more than compensated by the great number of individuals. In tropical climates one plant may be seen here, and another there, which, in their size, astonish an European, when he is told that they belong to the family of the grasses; but then he should search in vain for those swards of grass, and green meadows, with which almost the whole aspect of his own climate is verdant. The gramineous plants form one of the most important families of plants in every climate. The maize or Indian corn of the west, the rice of the east, the wheat and other grains of the north, equally belong to it.

In those plants the stem is hollow, except at the nodi, or joints, where transverse partitions intercept the cavity, dividing it into many cells. In the bamboo these cells and partitions are so large that, it is well known, lengths of that plant are used as cases to contain papers. If the gradual development of our native species be attentively observed, it will be found however, that the stem is originally solid; and afterwards becomes hollow, in consequence of its increasing in diameter more rapidly than new tissue can be formed.

Nearly allied to stems are the *branches,* which in their mode of growth and development, exhibit the same appearances as the trunk from which they issue. They originate in a bud, and form a cone which also consists of pith, wood, and bark; or, rather, they form a double cone, for the insertion of the branch into the trunk forms also another cone whose base is at the circumference, and whose apex is at the centre, at least if it has been formed in the first year of the growth of the plant. Branches, in their development, assume almost all the varieties of position. The lower branches of trees are found to be generally parallel to the surface of the soil on which they grow, even though that surface should be the sloping side of a hill; while those nearer the top of the tree approach more to the vertical position.

The *leaf-bud*, which, in the beginning of spring, is so very conspicuous on the trees of temperate climates, is by no means common to all plants, nor to plants of all climates. It is only in the woody plants of cold climates that the presence of these appendages can be ascertained with certainty; and in these no new part is added, whether proper to the leaf or flower, without the intervention of a bud. When the young shoot is produced, it is at the same time furnished with buds, which are again extended into new shoots in the following spring; and thus the bud is to be regarded as forming not only the cradle, but also the winter quarters of the shoot, for which its coat of tiled and glutinous scales seems admirably adapted.

After the leaf buds have made some progress, and have been covered with scales for their protection, they form, beneath the scales, a number of rudimentary leaves, which are ready to unfold and augment in size with rapidity as soon as the branch is called into action. Nothing can be more curious than the manner in which these little rudiments of leaves are packed up within the bud, or the exactness with which the particular mode of folding, which may be peculiar to a given species, is observed in every bud of every individual.

The *leaf*, which is a temporary part of the plant, is an expansion of the bark at the base of a leaf-bud, prior to which it is developed. In most plants it consists of cellular tissue filling up the interstices of a network of fibres that proceed from the stem, and ultimately separate from the bark by articulation; but in many monocotyledonous plants no articulation exists, and the base of the leaf only separates from its parent stem by rotting away.

There is no part of the plant to which it owes so much of its beauty as the foliage, nor are there any of its organs of more essential utility to its vegetation. Of the importance of leaves in the vegetable economy we have sufficient proof from the fact, that when they are stripped off the fruit comes to nothing, as is exemplified every year in the case of gooseberry bushes, the leaves of which have been destroyed by caterpillars. The berries then are found to become hard and insipid; and when the leaves of a tree are injured by frost, mildew, or other cause, the whole vegetation of that season is proportionally deteriorated.

The distribution of plants into dicotyledonous and monocotyledonous is strongly marked in the leaves, as well as in the other parts of the plant. In dicotyledonous plants the vessels of the leaves commonly branch off in all directions from the midrib or bundle of vessels which runs along the middle of the leaf, while in monocotyledonous plants they generally are found running parallel along the leaves.

Leaves appear to the naked eye to be composed merely of a thin homogeneous substance, and generally possessing little interesting to the ordinary observer; but when, by the assistance of the microscope, their internal structure is displayed, we find it to be one of the most complicated and highly organized character, as might be inferred from the important functions they are destined to perform. Besides the vessels and their numerous pores, the parenchyma with its green granules which impart colour to the leaf, and the epidermis which covers the whole, many leaves are beset with hairs, strings, spines, and other appendages. In reference to these, it may be remarked that they generally belong to the vascular structure; and as by cultivation we do not increase the vessels of a plant nearly in so great a proportion as we increase the cellular substance, so many leaves which are partially covered with hairs and prickles in their natural state, lose these appendages by cultivation.

Besides ministering to the nutrition of the vegetable generally, leaves are immediately concerned in forming the buds. These, as we already have had occasion to observe, are placed at the root of the leaf-stalk, and on their development the attachment of the leaf, in a great measure, appears to depend. If the bud be fully developed for its winter state, the leaf, if articulated to the branch, falls, though it be not previously dead. But we are not to consider the expansion of the bud as the only cause for the fall of the leaf. Its death, in consequence of the decay of its organization, from excessive activity, or from want of nourishment—storms and inclemency of the atmosphere generally, and more particularly the colds on the approach of winter, cause the branch and the base of the leaf-stalk each to contract upon itself, and so to separate at the articulation between them, in consequence of which the leaf falls.

We now come to consider the flower and fruit, which are the parts through the instrumentality of which the species is continued.

V.—THE FLOWER.

Although individual plants often possess great longevity, yet they are subject, in common with all organized matter, to the laws of increase, decay, death, and reproduction. The various species of vegetables upon the face of the earth are kept alive, not by the continuance in life of individuals originally created, but by a series successively produced, and bearing the relation to those which preceded them of parents and offspring. To accomplish this end, every plant is furnished with a peculiar apparatus, termed the *reproductive organs*, and familiarly known by the name of flower and fruit, which form the embryos of the future plants. There are species, indeed, whose reproductive organs have not yet been detected; but there is every reason to believe that this does not arise from any imperfection attaching to them, but rather from our imperfect observations, and that, from the oak of a thousand years to the lowest fungi, every species is furnished with organs for producing seed after its kind, or some apparatus serving the same purpose.

The flower, like the leaf, is a temporary part of the plant, issuing generally from the branches, but sometimes from the root, stem, and even leaf; being the apparatus destined by nature for the production of the fruit, and being also distinguishable, for the most part, by the brilliancy of its colouring or the sweetness of its perfume. These, combined with the delicacy of structure which flowers usually exhibit, afford subject of admiration to every observer, and have accordingly attracted attention in all ages on account of these properties.

For convenience, the different parts of the flower may be distinguished either as being essential for the continuance of the species by the formation of fruit or seed; or non-essential, comprehending those parts which, though generally present, and no doubt useful, are neither always found, nor indispensably necessary. Those parts which are most essential, however, are by no means the most conspicuous to the eye; they are placed towards the centre of the flower, and are, in general, small and unattractive, compared with the other parts.

In the most perfect flowers four sets of organs may be observed, placed, as it were, in circles, the one within the other, so that the fourth, or innermost one, occupies the centre. Of all the four, this innermost one is the most essential; for it is sometimes capable of giving rise to a young plant independently of all the others, which are useful only in relation to it. This is the case in a few species of gramineous plants, onions, and others called viviparous. But, for the production of true seed, the third set of organs, or that which surrounds the central one, is essential; in fact, the third and fourth are of different sexes, and for the production of embryo individuals, the one is necessary to render the other fertile.

The floral envelopes are the parts least essential. They generally consist of two different parts, the *calyx* and the *corolla*, which are in most cases easily distinguished from each other; but it also frequently happens that they so much resemble each other, and sometimes even other parts of the floral appendages, as not to be readily distinguishable. In some cases the parts of which they are composed are green like leaves, particularly in the calyx; but more frequently they are of a different colour and more delicate texture.

Commencing with the outermost of the sets of organs mentioned, the *calyx* or flower cup comes first to be described. It forms the external covering of the flower, and serves as a protection for the more delicate parts within, until the period arrives for their full expansion. It frequently consists of only one leaf, more or less deeply divided into segments as in the bell flower; but it is also often formed of several divisions, or *sepals*, united together at the base, and forming either one or more coverings for the parts within. In what are termed compound flowers the sepals are numerous, and beautifully arranged over each other, as may be seen in the calyx of the thistle and numerous other plants.

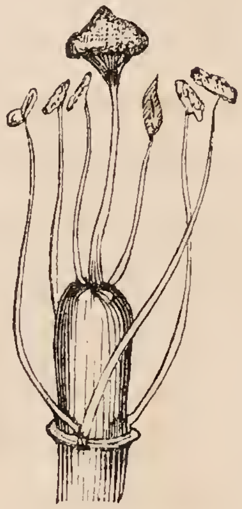
Within this external covering is found the *corolla*, which is the coloured part, and that to which flowers owe most of their beauty. Like the calyx, the corolla is very often composed of one leaf variously divided at the margin; and in many cases, also, it is composed of several leaves. The several divisions of the corolla are termed *petals;* and when it consists of a single petal, more or less deeply divided, it is said to be *monopetalous.* When the petals first burst from the calyx, and expand in all their beauty, they still serve to protect the central parts of the flower. They are, at first, carved inwards, forming a concavity around the delicate organs which occupy the centre. This not only shelters them from external injury, but also reflects the sun's rays upon them like a concave mirror; thus nurturing them, as it were in a hot-house. When these parts are full grown, the artificial heat being no longer necessary, and the admission of light and air being not only safe, but advantageous, the petals expand, leaving the internal organs exposed to the free agency of these elements.

The corolla is generally a very fleeting part of the reproductive system, a few hours often constituting the natural term of its duration. The greater number of flowers require the genial rays of the sun to expand them; but there are others so exquisitely delicate, that they blow only in the dark, and wither as soon as the sunbeams of the morning alight upon them. It is remarkable, too, that the most beautiful blossoms are, in general, those which wither soonest—a circumstance that has not been forgotten by the poet, in mourning over the fleeting nature of beauty, nor by the moralist, in directing our attention to another world, the fashion of which passeth not away.

Both the parts which have now been described are not always present. Not unfrequently one covering only exists around the essential organs, which partakes sometimes of the characters of the one, and sometimes of those of the other. Thus the beautiful blossoms of the lily and tulip are unprotected by any external flower-cup; and many plants might be mentioned that are destitute of a coloured flower. In other species, again, as in the grasses, both parts are frequently present, but they are very like each other, and do not naturally admit of a division into flower-cup and blossom.

Immediately situated within these parts we find the *stamens* and *pistils* the only essential parts of the flower. In the annexed figure, which exhibits the usual manner in which these parts are arranged, the calyx and corolla are removed that they may be better seen. Here the pistil is seen proceeding from the centre of the flower, there being only one in number, and it is surrounded by the stamens which are more numerous, amounting in the figure to six.

Fig. 62.



The stamen answers the same purpose in plants as the male organs in animals, in other words it contains the substance by which the fecundation of the germs is effected. It generally consists of two parts; the *anther*, or head, which is a kind of membranous bag, having a double internal cavity, formed of two cells in contact with each other, and the *filament*, or stalk, by which the anther is supported. The anther contains the *pollen*, a substance commonly formed of small vesicular grains, which contain the parts necessary for fecundation.

The essence and perfection of the stamen consist in the presence of the anther, the filament being often wanting, or so short as not to be observed. In order that the anther may be fitted for performing the functions allotted to it by nature, it must not only contain pollen, but it must also open, that the pollen may come in contact with the stigma, or female organ; otherwise fecundation could not take place. The number of stamens in the different families of plants is various, though if it be not very great, it is remarkably constant in the same species; and hence has been made use of by Linnæus as a character on which to found his celebrated system. The manner in which they are inserted affords also distinctive characters.

The pollen generally presents the appearance of a powder, composed of extremely minute grains. These grains in general exhibit a uniform organization. Each grain is composed of two membranes, the one external, thicker, and furnished with pores, and sometimes more or less prominent appendages; the other internal, thin, transparent, and having no adhesion to the first. When submitted to the action of water, the inner membrane swells, the outer bursts at some part of its surface, and through the opening thus formed there issues a tubular prolongation. The cavity of the inner membrane is filled with spherical granules of extreme minuteness, which appear to perform the most important part of the act of fecundation.

Such is the structure of the stamen, and such are the phenomena which the pollen presents in bursting. But before detailing the functions which it performs in the vegetable economy, it will be necessary to describe the central organ to which the anther is subservient.

The *pistil*, it has been said, occupies the centre of the flower, and is immediately surrounded by the stamens. The form of the pistils varies greatly in different plants, and the number found in a single flower is also various; but, in general, they are not so numerous as the stamens, and the number one is very common. Like the stamens, the number is very constant in the same species of plants, and on this property, a number of the orders in the Linnæan system of classification is founded.

The pistil generally consists of two parts, a head and stalk, the former being called the *stigma*, and the latter the *style*. The form of the stigma is frequently globular, but it is often expanded into a broad and flattened top, as may be seen in the tulip; while in other cases, the top of the pistil is merely a continuation of the style, without any sensible enlargement. *Fig.* 63 represents the pistil in the primrose, in which the stigma, style, and seed-vessel at the base of the style, are all seen. *Fig.* 64 is the pistil of the iris or flag, in which the stigma, instead of having a globular form, as in the primrose, is expanded into three broad leaves like those of the flower. The form assumed by this organ in the wallflower or turnip is seen in *Fig.* 65, the stigma resting almost immediately on the seed-vessel. *Fig.* 66 represents the form of the pistil in the grasses, where there are generally to each seed-vessel, which is, in fact, a grain, two long tapering styles covered with hair.

Fig. 63.

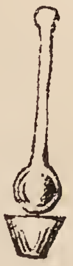


Fig. 64.

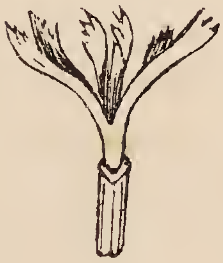


Fig. 65.

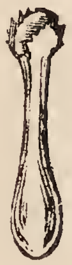
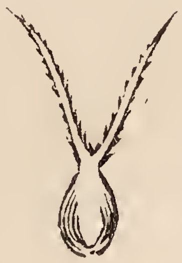


Fig. 66.

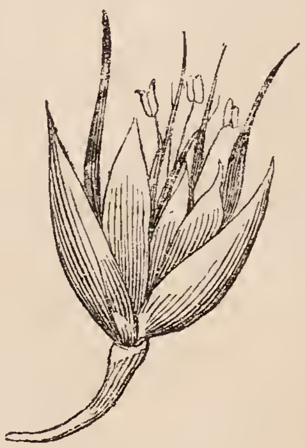


The style, though generally present, is not always found to be so ; and, in this case, the stigma is said to be *sessile.* It is not more essential to the pistil than the leaf-stalk to a leaf, or the filament to a stamen. Anatomically considered, it consists of a column of vascular tissue surrounded by cellular substance, the former communicating on the one hand with the stigma, and on the other with the vascular tissue of the ovarium. It is usually taper, often filiform, or thread-shaped, sometimes very thick, and occasionally angular. It is commonly enlarged towards the base, where it appears to be hollow, and composed of one or more compartments.

The upper extremity of the stigma is without a cuticle, in consequence of which it has almost uniformly a humid surface. Strictly speaking, the stigma is merely the secreting surface of the extremity of the style, although the term is often applied to certain portions of the style, especially to such portions of its extremity as appear enlarged.

The appearance of the flower in the cereal gramina, is seen in *Fig.* 67. The calyx here is a chaffy membranaceous substance, which, in botanical language, is termed a *glume.* It is not, however, formed like a cup. Sometimes it is composed of one piece only, at other times of two distinct pieces or valves, and these valves vary in figure in different plants. The stamens here present the usual appearance, being terminated by two solid anthers, but the pistils, as shown in the figure, are merely prolonged tapering styles without any visible stigma. The number of stamens in this case is seen to be three, and that of the pistils two.

Fig. 67.



On an examination of the ovary, or seed-vessel, from which the pistils immediately proceed, it will be found that the seeds will have made but little progress towards maturity, until the pollen of the anther has been shed upon the stigma, and, consequently, impregnation taken place ; and if the anthers be cut away before they have performed this important office, and the flower, at the same time, guarded, so that pollen cannot be conveyed to it, either by insects or directly by other plants, the seeds will never reach maturity, or contain an embryo. The flower will, perhaps, continue longer in bloom than it would otherwise have done, and the seed vessel may expand to a certain extent, but the seeds will be deficient in their internal organization, and unfit for the purpose of reproduction. For the production of perfect seeds, it is, in fact, necessary that the pollen burst upon the summit of the stigma.

Although the sexual organs just described are very generally present in flowers, yet they are not universally so. Many flowers are what are denominated *unisexual*, that is, they contain stamens only, or pistils only. These unisexual flowers are sometimes met with on the same plant, sometimes on different plants, while, in other cases, plants are met with having all the three kinds of flowers upon them at the same time. The flowers are said to be *hermaphrodite* when both stamens and pistils are present in the same flower. When they are in different flowers, though on the same plant, they are *monœcious;* and when on different plants, they are said to be *diœcious.*

When the stamens and pistils are situate near each other, as in the cases whether of hermaphrodite or monœcious flowers, the elastic spring with which the anther flies open will generally be sufficient to disperse the pollen, so that it must infallibly reach the stigma. But, even with this facility, the impregnation of the seed would, in many cases, be imperfect without further aid; especially in such as do not perfect stamens and pistils at the same time. For although the action of the wind cannot but be efficacious in many cases, yet in others it may naturally give to the flower a direction calculated rather to prevent than to aid the access of the pollen, by causing the corolla to veer round like a vane, according to the quarter from which it may happen to blow. In these cases, however, the object is effected through the agency of insects, the object of which is the discovery of honey, in quest of which, whilst they rove from flower to flower, and rummage the recesses of the corolla, they unintentionally cover their body with pollen, which they convey to the next flower they visit, and brush off in the manner in which it was acquired.

In consequence of becoming acquainted with the use of the pollen, and the necessity of its being deposited on the summit of the stigma for the production of seed, we are able to understand the intimate connexion which is always observed between the state of the weather at the time of its blossoming, and the quality of the fruit or grain. A heavy shower, by washing away the pollen, or causing it to burst in the anther, or otherwise than on the stigma, may prevent impregnation, and destroy the seed; and we find that, what the rains and winds of midsummer too often do for our crops, the cold blasts of spring do for our fruit trees. Yet nature has, in this function, more than in most others, made ample provision against such accidents, by surrounding these essential parts with the envelopes which have been described, and making the bursting of the anther depend, in a great measure, upon the state of the weather; for, if it be not fine, it will remain a long time even in an expanded blossom without bursting.

After impregnation has taken place, peculiar changes are manifested in both flower and fruit. At this period, the flower has attained its ultimate state of perfection, and displayed its utmost beauty of colouring and richness of perfume. But as it is no longer wanted, so it is no longer provided for in the economy of vegetation. Its period of decline has commenced, as is indicated first by the decay of the stamens, then of the corolla, and afterwards of the calyx, which wither and shrink up, and finally detach themselves from the fruit altogether, except in some particular cases, in which one or other of these becomes permanent, and falls only with the fruit. The stigma exhibits also similar symptoms of decay, and the style itself often perishes. The parts contiguous to the flower, such as the floral leaves, are sometimes also affected; and, finally, the whole plant, at least in the case of annuals, begins to exhibit symptoms of decay. But while the flower withers and falls, the ovary is advancing to perfection, swelling and augmenting in size; and, receiving now all the nutriment by which the decayed parts were formerly supported, its colour begins to assume a deeper and richer tinge, its figure is also often altered, and new parts are even occasionally added. But the principal changes resulting from impregnation are effected in the seed itself, which, though previously a homogeneous, gelatinous mass, is now converted into an organized body, or embryo, and becomes adapted for the reproduction of the species.

If the pollen of one species of plants is employed to fertilize the ovules of another, the seeds will often produce plants which are strictly intermediate in all respects between the two parents. Such productions are termed hybrids, and are manifestly analogous to mules among animals. The conditions necessary for the production of a hybrid are not ascertained beyond the fact, that those species only are capable of forming them which are nearly allied to each other, and are either of the same genus, or of genera which scarcely differ. It has been suggested that the possibility of producing hybrids was limited to species whose pollen was nearly of the same form and dimensions; but this is to be regarded as mere conjecture. Not more than forty kinds of hybrids have been found *naturally* produced in a wild state, between well-defined species, and all of these are described as barren or incapable of perfecting their ovules; so that they can never be reproduced by seed, though they may be propagated by other means. It appears to have been ascertained that hybrids may be fertilized by the pollen taken from one or other of the parent species, and that the seed thus obtained will produce plants intermediate between that species and the hybrid, and thus a return may gradually be made to one of the original types. It has been equally asserted of animals, that although mules never produce young between themselves, yet a female mule may become productive by a male of one or other of the parent species.

The discovery of the sexual organs of plants was accordingly followed by attempts, on the part of the cultivator, to produce new and improved varieties suited to field and garden culture. Being aware of the great advantages of crossing in the improvement of the domestic animals, the most sanguine expectations were entertained as to the result of similar processes in the vegetable kingdom; and although these have not been altogether realized, owing, perhaps, to the want of a sufficient number of experiments, yet the results have been interesting in a high degree.

VI.—THE FRUIT.

The fruit is the ovarium, or pistil, arrived at maturity; but although this is the sense in which the term is strictly applied, yet, in practice, it is extended to whatever is combined with the ovarium when ripe. Thus the fruit of the pine-apple consists of a mass of bractæ, or floral leaves, calyces, corollæ, and ovaria; and that of the nut, the acorn, and many others, of the superior dry calyx and ovarium.

Every fruit consists of two principal parts, the *pericarpium* and the *seed*, the latter being contained within the former. The form of the pericarpium, or seed-vessel, the compartments into which it is divided, the number of seeds which it contains, and the manner in which they are attached to their covering, are extremely various. To enter into a minute description of the peculiarities of form presented by this organ, would not, however, answer any practical purpose; and the structure and properties of the seed have been already explained.

VII.—GENERAL CONSIDERATIONS.

It now remains, before concluding this brief sketch of the vegetable economy, to add a few observations on vegetable nutrition. Hitherto we have been occupied chiefly in considering the forms only which the various organs of plants assume, and the manner in which they may be considered to be mutually related. We have been examining merely, some of the details of that exquisite mechanism, by means of which the vital principle is enabled to act, and may be acted upon; and thus produce all the varied and complicated results, which the phenomena of vegetation present.

At this period of our inquiry, it would be an unnecessary waste of words to offer any proof that plants are organized bodies, endowed with life, originating from a seed, gradual in their development, and after having attained perfection, that they as gradually decay, die, and are decomposed. In fact, the general phenomena of life and death are scarcely less striking in the vegetable than in the animal kingdom; and probably, the vital principle, considered apart from sensibility, is something of the same kind, if not the very same thing, both in animals and vegetables. This similarity or unity in essence must lead us to expect what experience has shewn to be the fact, that a considerable analogy exists between the functions of animal and vegetable life.

Life, though at the best of only temporary duration in organized bodies, cannot be maintained in them at all without the continued application of certain stimulants. All require peculiar kinds of food, according to their respective natures; a sufficiency of heat, air, moisture, and other circumstances. If entirely deprived of these stimulants they soon die; and even when they are only partially subjected to their influence in a less proportion than is requisite for a free exercise of their functions, they languish and become sickly. But besides the various salutary influences to which all living bodies must be submitted, in order to secure for them a due and healthy performance of their several functions, there are others to which they may be subjected, which are decidedly noxious under all conditions, and which must ultimately prove fatal to them, if they had not the power of escaping from their presence, or at least of modifying their effects. In proportion as a living being possesses a greater power of choice, either in profiting by those circumstances which are favourable, or in avoiding those which are hurtful to its existence, we may consider it to be more elevated in the scale of nature, and further removed from the condition of mere brute matter. Most animals, by the faculty which they possess of locomotion, have a great advantage in this respect over plants; and even those among the very lowest tribes of animals which are permanently fixed to one spot during the whole period of their existence, still possess a certain power of selecting their food, and rejecting that which is noxious to them, which vegetables have not. The consequence is, that the continued influence of external agents is found to be far greater in modifying the character of plants than of animals. As a sort of compensation, however, the vital principle in plants is so much less energetic than in animals, that they are not so readily affected as these latter, under any merely casual or temporary alteration in the external conditions under which they may be placed.

Before entering on the subject of vegetable nutrition we might examine into the properties of vegetable matter, and ascertain the agency allotted to the different parts in the vegetable economy. It is interesting to contemplate the action of the tissue which, by means of its elasticity, contributes in such an essential degree to the fertilization of the ovary, and the dispersion of the seed when ripe; of its hygroscopic properties by which fluid substances so easily enter into the living plant, and contribute to its growth, and the endosmosic action so closely connected with these hygroscopic properties, which is now brought forward in illustration of the phenomena of the flow of the sap, instead of the long acknowledged theory of capillary attraction. The excitability and tenacity of life possessed by plants is also deserving of observation, as well as various other phenomena of the vegetable kingdom. But these, though interesting to the physiologist, are not of such practical importance to be noticed at length in this place.

After the embryo, as we have seen, has been converted into a plant, and after it has exhausted the store of nutritious matter prepared for it by the cotyledons, it has then to seek its future nourishment from the soil by means of its roots, and from the air by its leaves. It remains to be considered then, what are the substances which plants derive from the earth and the atmosphere.

In another part of this treatise we have seen that the soil is composed of certain mixtures of earthy and organic matters in various states of combination, with aqueous moisture and gaseous substances proceeding from the decomposition of the organic matters of the soil. The atmosphere again is known to be composed of oxygen, nitrogen, and carbonic acid, with a varying portion of aqueous vapour. All these substances, however, are not indiscriminately taken up by the growing plant; part only are selected, and in certain proportions.

Many conditions are necessary for the life of plants, those of each genus require special conditions, and should but one of these be wanting, although all the rest be supplied, the plants will not be brought to maturity. The organs of a plant, as well as those of an animal, contain substances of the most different kinds, and the food which can serve for the production of all the organs of a plant must necessarily contain all its elements. The elementary ingredients of all plants consist of carbon, oxygen, and hydrogen in various proportions, and under various modifications. Now most soils would yield these ingredients, and yet it is well known that certain plants thrive only in particular soils. Nor does it follow, that these ingredients enter the plant in an uncombined state, because they do not actually exist in this free and uncombined state in all soils. A power of selection then is made by the plant, and this it is enabled to do by the vital powers of assimilation by which it is endowed.

With regard to the food of plants derived from the atmosphere, the supply is pretty regular; at least in as far as the gases are concerned, for they are not found to vary materially in their proportions on any part of the surface of the globe; but the quantity of moisture contained in the atmosphere is continually varying, so that in the same season there is not always the same quantity, though in the course of the year the deficiency is perhaps made up. From the atmosphere, therefore, there is a regular supply of vegetable food kept up by nature for the support of vegetable life, independent of the aid of man; and if human aid were even wanted, it does not appear that it could be of much avail. This, however, is by no means the case with regard to soils; for if soils are less regular in their composition, they are at least more within the reach of human management, and in the event of their not being sufficiently favourable to culture, their peculiar defect or excess must be supplied or retrenched before they can be brought to a state of fertility.

But soils in a state of culture, though consisting originally of the due proportion of ingredients, may yet become exhausted of the principle of fertility by means of too frequent cropping, whether by repetition or rotation of the same, or of different crops; and in this case it should be the object of the physiologist as well as the practical cultivator, to ascertain by what means fertility is to be restored to an exhausted soil, or communicated to a new one. This will comprehend the improvement of soils, by tillage and other means, of which we have already treated.

But it may be asked in what manner the fertility of soils is restored by these means, and made more subservient to the purposes of vegetation. It will be sufficient for the object of the present section, in addition to what has been already said when treating of these subjects themselves, to remark, that, in the case of draining, the amelioration is effected by means of the removal of superfluous moisture; in the case of burning, by the decomposition of the vegetable substances contained in the turf, and subjected to the action of the fire, which disperses part also of the superfluous moisture, but leaves a residue of ashes favourable to future vegetation. In the case of the rotation of crops, the fertility is not so much restored as more completely developed and brought into action, because the soil, though exhausted by one species of grain, is yet found to be sufficiently favourable for another, the food necessary to each being different, or required in greater or less abundance. In the case of the repose of the soil the restored fertility may be owing to the decay of vegetable substances that are not now carried off in the annual crop, but left to augment the portion of vegetable mould; or to the accumulation of fertilizing particles conveyed to the soil by rains. But it often happens that the soil can no longer be ameliorated by any of these means, and in this case there must be a direct and actual application made to it of such substances as are fitted to restore its fertility. Hence the indispensable necessity of manures which consist chiefly of animal and vegetable remains, that are buried and finally decomposed in the soil, from which they are afterwards absorbed by the roots of plants, in a state of solution.

In the course of this inquiry it has been seen that the soil is the chief source whence the nutriment of the growing plant is derived. Certain substances are absorbed from it in a fluid state, which are then sent upwards into the stem, afterwards impelled into the leaves, whence they descend through the liber, transferring themselves to the inmost parts of the wood. This fluid is called the sap. When first introduced into the system, and even when altered in some degree, by having dissolved the various substances it encounters in its passage, it is called *true sap;* afterwards, when its nature has been more changed by elaboration in the leaves, it becomes what is termed *proper juice.*

If the sap be examined in its most simple state, it will be found to consist of water, mucilage, and sugar. As the last two can scarcely have been absorbed directly from the earth, it is inferred that as soon as the fluids, taken up by the roots, entered the system, they suffer some chemical decomposition, the result of which is mucilage and sugar. In addition to the supply of sap which is obtained by the roots, a certain quantity is, no doubt, also absorbed from the atmosphere by the leaves; as is evident from succulent plants, which will continue to grow and acquire weight long after their roots are severed from the earth. This absorption on the part of the leaves chiefly takes place at night, or in cloudy weather; while perspiration, on the other hand, goes on in the day time in bright weather.

That the sap is in motion in plants in one direction or other, if not all the year, at least at occasional periods, their bleeding in spring and autumn, on being wounded, sufficiently illustrates. The plant always bleeds most freely about the time of the opening of the bud; for in proportion as the leaves expand the sap flows less copiously, and when they are fully expanded, it would seem to be almost entirely suspended. But this suspension is only temporary, for the plant may be made to bleed again in the end of the autumn, at least under certain conditions. Palms may be made to bleed at any season of the year; and although this is not the case with plants in general, yet there is sufficient proof that the colds of winter, even in this climate, do not entirely prevent the sap from flowing. Buds exhibit a gradual development of parts throughout the whole of the winter, as may be seen by dissecting them at different periods. So also do roots. Evergreens retain their leaves; and many of them, such as the arbutus, laurustinus, and the beautiful tribe of the mosses, protrude also their blossoms, notwithstanding the rigour of the season. All this could not possibly be accomplished if the motion of the sap were completely suspended.

The cause of the motion of the sap is a subject which has long excited great curiosity, and has given rise to numberless conjectures. From the latest experiments and most accurate observations, it would seem that the cause of the motion of the sap upwards is, as far as we have any means of assigning an immediate cause to the phenomenon, the development of the buds and leaves. When a young bud or a leaf is first excited to growth in the spring, the fluids it contains are increased in density by evaporation; endosmose immediately takes place between it and the tissue below it, which latter parts with the thinnest portion of its contents, and then acts by endosmose on the inferior tissue immediately adjoining; and thus the whole fluid matters in the plant are put in motion, from the extremity of the branches to the points of the roots; the moment the spongelets are affected, the fluid matters in the soil are attracted through their sides, and by these means a complete motion throughout the system is established. Hence the appearance of the foliage of plants in spring is not the effect of the ascent of the sap, as is the general opinion, but the cause of it.*

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* For the endosmosic theory, to which so much importance is now attached, we are indebted to M. Dutrochet. He found that small bladders of animal or vegetable membrane, being filled with a fluid of greater density than water, securely fastened, and afterwards immersed in water, acquired weight; he also ascertained that, in the event of the experiment being reversed, by filling with water, and immersing them in a denser fluid, the contrary took place, and the bladders lost weight. He took a small bladder and filled it with milk, or gum arabic dissolved in water, to the mouth of which he adapted a tube, and then plunged the bladder in water. In a short time the milk rose in the tube, whence he inferred that water had been attracted through the sides of the bladder. This experiment was also reversed, by filling the bladder with water, and plunging it into milk; and the fluid then fell in the tube, whence he inferred that water had been attracted through the bladder into the milk. This phenomonon

That there must be an exceedingly rapid flow of sap in many plants, is evident from the great loss which they often experience by perspiration,—all of which must be restored by fluid absorbed by the roots. A young vine leaf, in a hot day, perspires so copiously, that, if a glass be placed next its under surface, it is presently covered with dew, which, in half an hour, runs down in streams. Hales found from experiment a sunflower lose a pound and a quarter, and a cabbage nearly an equal weight, in a day, by perspiration.

With this function are connected all the phenomena that attend transplantation. If a growing plant be removed from one situation to another, in the summer, it will die; because its spongioles will be so much destroyed as to be incapable of absorbing fluid from the soil as fast as it is given off by the leaves; and hence the system will be emptied of fluid. But when a plant is growing in a pot, it may be transplanted at any season of the year; because its spongioles, being uninjured, will be able to counterbalance the loss sustained by evaporation, as well after transplantation as before.

With regard to the vessels through which this universal diffusion of the sap takes place, it has been found that its upward course is always through the woody fibre, and probably also through the ducts; and that it passes downwards through the woody fibre. But there can be no reasonable doubt that it is also dispersed through the whole system by means of some permeable quality of the membranes of the cellular tissue, which is invisible to our eyes, even aided by the most powerful glasses. It has also been suggested that the sap finds its way upwards, downwards, and latterly, through the intercellular passages which exist at the points of union of every individual elementary organ.

Although the fluid matters absorbed from the soil undergo a change on entering the plant, yet the process of elaboration is chiefly performed in the leaf. A large portion of it is evaporated, so that the

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Dutrochet called *endosmose.* It is believed that it is by endosmose that vapour is absorbed from the atmosphere, and water from the earth; that sap is attracted into fruits by reason of their greater density; and probably that buds are enabled to empty the tissue that surrounds them when they begin to grow. The endosmosic action, in fact, will perhaps be found the most ready explanation of most of the phenomena connected with the movement of fluids.—*See Lindley's Introduction to Botany*, &c., p. 226.

residuum is of a greater consistence, but the leaves also possess the power of absorbing moisture from the atmosphere when it is wanting. The properties of the sap are further changed by the exhalation and inhalation of gaseous substances. The leaves have been found to vitiate the atmosphere during the night by inhaling oxygen abundantly, and exhaling a small quantity of carbonic acid; and to restore the air to its purity in the sun's says, by decomposing their carbonic acid, and parting with their oxygen.

When the sap has been duly elaborated in the leaf, by the means that have just been mentioned, it assumes the appellation of *cambium*, or the proper juice of the plant. In this ultimate state of elaboration it may often be distinguished by a peculiar colour, being sometimes white, as in the several species of spurge, and frequently yellow, as in celandine. To the production of these effects, however, light is absolutely necessary, though a suitable degree of heat, air, and moisture, are all that are essential to vegetation. Plants, it is true, may be made to grow in the dark; but they are equally destitute of verdure and of those strong odours which often characterize them when produced in the light. They are also much less combustible, and those oils and resins which the plant usually secretes are no longer found. These phenomena are the origin of that process in horticulture called *blanching*, by which the stems or leaves of plants are excluded from the light; and thus their naturally too strong or acrid flavours or tastes are tempered to such a degree as often to be highly palatable, especially when modified by the presence of saccharine matter.

There can be no question of the general purposes afforded to the vegetable constitution by these functions of leaves. But when we attempt to consider how the peculiar secretions of different species and tribes of plants are formed;—how the same soil and the same atmosphere should, in a leaf of the vine, or sorrel, produce a wholesome acid, and in that of a spurge, or manchineel, a most virulent poison; how sweet and nutritious herbage should grow among the acid crowfoot and aconite;—we find ourselves totally unable to comprehend the existence of such wonderful powers in so small and seemingly simple an organ as the leaf of a plant. The agency of the vital principle alone can account for these phenomena, though, to our limited understandings, it cannot explain them. The thickest veil covers the whole of these processes; and so far have philosophers hitherto been from removing this veil, that they have not even been able to approach it.

If we reflect upon these phenomena, our minds can scarcely fail to be deeply impressed with admiration at the perfect simplicity and, at the same time, faultless skill with which all the machinery is contrived upon which vegetable life depends. A few forms of tissue, interwoven horizontally and perpendicularly, constitute a stem; the development by the first shoot that the seed produces, of buds which grow upon the same plan as the first shoot itself, and a constant succession of the same phenomena, causes an increase in the length and breadth of the plant; an expansion of the bark into a leaf, within which ramify veins proceeding from the seat of nutritive matter in the new shoot, the provision of air-passages in its substance, and of evaporating pores on its surface, enable the crude fluid sent from the roots to be elaborated and digested until it becomes the peculiar secretion of the species; the contraction of a branch and its leaves forms a flower; the disintegration of the internal tissue of a petal forms an anther; the folding inwards of a leaf is sufficient to constitute a pistil; and, finally, the gorging of the pistil with fluid which it cannot part with causes the production of the fruit.

We might now enter upon the interesting and important subject of vegetable chemistry, by which a knowledge is obtained of the component parts of plants. Seeing that they are not merely organized beings, but also beings endowed with a species of life, absorbing nourishment from the soil on which they grow, and assimilating it to their own substance, by means of the functions which have been described,; it is evident that little progress can be made in the explication of the phenomena of vegetable life, without some specific knowledge of the primary principles of vegetables, and of their mutual action upon each other. To enter at length into this subject, however, would far exceed the limits necessarily assigned to this article; those who are anxious for full information on the subject may consult any of the different elementary works on chemistry.

For the purpose of making any considerable proficiency in this intricate branch of science, an acquaintance with the elements of chemistry, and a facility in analyzing the several compound ingredients in plants, are indispensably necessary. If the object of the student be merely that of extracting such compound ingredients as are known to exist in the plant, the necessary apparatus is simple, and the process easy; but if it be that of ascertaining the primary and radical principles of which the compound ingredients are themselves composed the apparatus is then complicated, and the process difficult, requiring much time and labour, and much previous practice in analytical research.

Every distinct compound which exists ready formed in plants, is called a *proximate* or *immediate principle*, of vegetables. Thus sugar, starch, and gum, are proximate principles. Opium, though obtained from a plant, is not a proximate principle; but it consists of several mixed, more or less, intimately with one another.

The proximate principles of vegetables are sometimes distributed over the whole plant, while at others, they are confined to a particular part of it. They are very numerous in themselves, and, as has been seen, very diversified in their qualities. It is to the predominance of some particular one of these, that every species of vegetables owes its value and importance in domestic economy and the arts. The wheat and potato are, for example, chiefly valuable for the quantity of starch, or fecula, which they contain. The sugar-cane, *Saccharum officinarum*, owes its importance exclusively to the quantity of sugar which it produces; while many plants are valuable for the production of acids, oils, wax, resins, balsams, and other compounds. These are all extracted by mechanical means, such as pressure, washing, and decantation—operations which the most inexperienced can have little difficulty in performing. Of such processes consists the *proximate analysis* of vegetables.

The reduction of the proximate principles into their simplest parts constitutes their *ultimate analysis*. A very few constituent elements include all the component ingredients of vegetables. These are carbon, oxygen, hydrogen, and, occasionally, nitrogen, or azote. The same substances, indeed, form the animal fabric, a circumstance which would appear incredible, were it not fully verified by chemical analysis. It is not a little interesting, then, to contemplate the so apparently different structures composed of the same ingredients, and nearly in the same proportions, differing merely in the state of combination in which they exist.

The precise proportion of the simple elements found in plants is of much less importance to the cultivator than that of the compound ingredients, and is less deserving of attention. It is, however, certain, that they compose, as it were, the very essence of the plant, and constitute, by their modifications, the peculiar characters by which it is distinguished. Thus it has been found, that vegetable substances are always acid when the oxygen they contain is to the hydrogen in a greater proportion than in water;—that they are always resinous, or oily, or spirituous, when the oxygen they contain is to the hydrogen in a smaller proportion than in water;—and that they are neither acid nor resinous, but saccharine, or mucilaginous, or analogous to woody fibre, or starch, when the oxygen and hydrogen they contain are in the same proportion as in water. These facts, though devoid of any practical importance, are highly interesting to the physiologist and lover of botanical science.

Those principles are called foreign to plants which cannot be referred to either carbon, oxygen, hydrogen, or azote. Such, for example, are carbonate and sulphate of soda, nitrate of soda, the carbonates of potash, lime, and magnesia, and other mineral substances. Silica is found in large quantities in gramineous plants, and is usually situated in the cuticle; but, in the bamboo, it is also deposited largely in the hollow joints, under the form of the substance called *tabasheer*. The cuticle of the rattan palm contains such a proportion of silica, that it will strike fire with steel. In some species of *Salsola* so much as fifty per cent. of soda is sometimes found.

The preceding account of the vegetable economy is fraught with suggestions of the highest practical importance to the agriculturist. The final object of all the natural sciences is their application to purposes subservient to the wants and desires of man; and the study of the vegetable kingdom is one of the most important in this point of view.

Agriculture and gardening are the two arts which embrace the whole culture of plants to whatever purpose they are applied by civilized man. Their fundamental principles, as arts of culture, are the same, being, for the most part, suggested by nature, and explained by vegetable chemistry and physiology; and most of them have been put in practice by man, for an unknown length of time, without much reference to principles. All that is necessary, therefore, for this purpose, is to imitate the habitation of the plant, and to propagate.

To increase the number and improve the nutritive qualities of plants, it is necessary to facilitate their nutrition by removing all obstacles to their healthy and vigorous vegetation; and hence the origin of draining, removing surface incumbrances, and the various operations for pulverizing the soil. A certain proportion of moisture has been seen to be essential to vegetation, and where this proportion is exceeded, means must be adopted for its removal. Surface incumbrances are also injurious, inasmuch as they not only obstruct the operations of tillage, but also occupy a portion of the ground which would be more profitably devoted to the production of useful plants. In like manner, minute pulverization of the soil is necessary both before sowing the seed, and in many cases, during the growth of the plants, as in the case of those cultivated in drills.

For the purpose of increasing the quantity of cultivated produce, it is essential that the best species and varieties alone be employed for the purpose of reproduction. In this respect, the faculty of distinguishing varieties, and forming an idea of their relative value, at first sight, is an attainment much to be desired. Let it be supposed, for instance, that, in a field of wheat, there exists a plant, a new variety, having two more fertile joints in its spike, and equal to the surrounding wheat in every other respect, a person, unaccustomed to make the most minute observations, would scarcely observe such a variety, unless distinguished by some more peculiar badge; nor would any but a person versed in plants know that it was of superior value, if placed before him. How many varieties answering this description may have existed and escaped observation, which, had they been observed, and carefully treated, would have proved an invaluable acquisition to the whole community. The number of fertile joints in the spike of wheat varies from eighteen to twenty-two, and the inhabitants of the United Kingdom amount to nearly the same number of millions; therefore, as the produce is insufficient to supply the inhabitants with bread, it is evident that a variety, with two additional fertile joints, and equal in other respects to the varieties now in cultivation, would, when it became an object of general culture, afford a supply of bread to nearly two millions of people, without even another acre being brought under cultivation, or an additional drop of sweat from the brow of the husbandman.

To form new varieties of any of our cultivated plants, it is only necessary to take advantage of their sexual differences, and to operate in a manner analogous to crossing the breed of animals. Numerous experiments with this object in view have, at different times, been performed; and, among others, the following very interesting one, by Knight, the late President of the Horticultural Society. A variety of the pea was chosen as the subject of experiment, which had been degenerating, even when cultivated in a superior soil. Being thus a good subject of experiment, the male organs of a dozen of its immature blossoms were destroyed, and the female organs left entire. When the blossoms had attained their mature state, the pollen of a very large and luxuriant grey pea was introduced into one half of them, and not into the other. The pods of both grew equally, but the seeds of the half that were unimpregnated withered way, without having increased beyond the size to which they had attained before the blossoms expanded. The seeds of the other half were enlarged and matured, as in the ordinary process of impregnation, and exhibited no perceptible difference from those of other plants of the same variety; but when they were made to vegetate in the succeeding spring, the effect of the experiment was obvious. The plants rose with great luxuriance, indicating, in their stem, leaves, and fruit, the influence of this artificial impregnation, and the seeds produced were grey. By impregnating the flowers of this variety with the pollen of others, the colour was again changed, and new varieties obtained, superior, in every respect, to the original on which the experiment was first made, and attaining, in some cases, to a height of twelve feet.

The practicability of improving the species by impregnation is rendered strikingly obvious by these experiments; and the ameliorating effect is the same whether by the male or female, as was ascertained by impregnating the largest and most luxuriant plants with the pollen of the most diminutive and dwarfish, or the contrary. By such means any number of varieties may be obtained at the option of the experimenter, amongst which some will no doubt be found suited to all soils and situations. Knight's experiments of this kind were also extended to wheat, but not with equal success; for although some very good varieties were obtained, they were not found to be permanent. But the success of his experiments on the apple-tree was equal to his expectations. This was, indeed, his principal object, and no means of obtaining a successful issue were left untried. The plants obtained in this case were found to possess the good qualities of both the varieties employed, uniting the greatest health and luxuriance with the finest and best flavoured fruit.

The process of impregnation has been chiefly practised between different varieties of the same species; but two distinct species of the same genus will often produce an offspring intermediate in character between themselves, and capable of performing all its vital functions as perfectly as either parent, with the exception of its being incapable of perpetuating itself by seed; or should it not be absolutely sterile, it will become so in the second, third, or, at farthest, fourth generation. It may, however, be rendered fertile by the application of the pollen of either of its parents; in which case its offspring assumes the character of that parent by which the pollen was supplied.

To increase the number, improve the quality, and increase the magnitude of particular parts of vegetables, it is necessary to remove such parts as are not wanted, as the blossoms of tuberous and bulbous-rooted plants, when the roots are to be increased, and the contrary. When the production of the part to be removed is of little consequence to the cultivator, by removing it the nutritive matter, which would otherwise be expended in bringing it to perfection, is then directed to the maturation of the more valuable parts; thus it is seen that the practice is founded on a just view of the vegetable economy. Hence also the important operations of pruning, ringing, cutting off large roots, and other practices for improving fruits, and putting trees into a bearing state.

The preservation of vegetables for future use is effected by destroying or rendering dormant the principle of life, and by warding off, as far as practicable, the process of chemical decomposition. When vegetables or fruits are gathered for preservation, the air of the atmosphere is continually depriving them of carbon, and forming carbonic acid gas. The water they contain, by its softening qualities, weakens the affinity of their elements; and heat produces the same effect, by dilating their parts, and promoting the decomposing effect of both air and water. Hence drying in the sun, or in ovens, is one of the most obvious modes of preserving vegetables for food, or for other economic purposes; but not for reproduction, if the desiccation be carried so far as to destroy the principle of life in seeds, roots, or sections of the shoots of ligneous plants.

The whole art of culture is but a varied development of the above fundamental principles, all founded in nature, and, for the most part, rationally and scientifically explained on chemical and physiological principles. Hence the great necessity of the study of botany to the cultivator, not in the limited sense in which the term is often understood, as including mere nomenclature and classification, but in that more extended signification by which the student is also made practically acquainted with the structure and functions of the vegetable economy; by which he is enabled to modify his system of culture in such a manner as most effectually to acccomplish the end in view. As this knowledge has increased, the produce of the land has increased in a corresponding degree, and will further increase as physiological knowledge extends. Cultivated produce has hitherto outrun population, and, to all appearance, will always do so. From the increasing enterprise and scientific knowledge of the cultivators of the soil, not only the merits of many of the varieties of roots, grain, and grasses, now in existence, and as yet very little known, will be further elicited; but new varieties, and even genera, possessed of more useful properties than any of those now cultivated, will continue to be discovered.

VIII.—THE SUCCESSION OF CROPS.

Having treated of the vegetable structure, the phenomena of its growth, maturation, and decay, we are now prepared to consider the order in which the different species should succeed each other to enable the cultivator to derive the greatest amount of produce off his land.

The character and habits of the different plants cultivated for economic purposes has been seen to be very dissimilar. Some being cultivated for their seeds, and others for their roots, while a third class is produced for its foliage. Each of these classes is known to succeed only under certain circumstances having relation to fertility of soil and mode of cultivation. But the soil itself is found to retain its fertility only by following a fixed routine of culture. A certain degree of pulverization is to be maintained, and periodical applications of manures are to take place; but as the soil can neither be pulverized nor manured every year, and as pulverization and the application of manures are of more importance in the case of some crops than in that of others, it becomes necessary to ascertain in what order these crops shall succeed each other so that the fertility of the soil may be maintained.

It is well ascertained that all the cultivated plants tend to exhaust the soil in a greater or less degree when the produce is carried off the land; this exhaustion is found to be counteracted by the application of manures. It would appear then, that if manures could be applied in sufficient quantity, there would exist no necessity for following any particular order of succession in the cultivation of crops. This application will, no doubt, prolong the period of greatest deterioration, but it is known from experience that a profitable return cannot be maintained from the same kind of crop even with an unlimited supply of manure. The impossibility of maintaining to perfection the same sort of crop on the same piece of ground in a well cultivated garden, illustrates, in a striking manner, the limited powers of manure in this respect; and in the field when the grain crops are allowed to ripen their seeds the power of manure is still more limited.

To avoid the serious evil of deterioration of soil and crop, which neither labour merely, however dexterous, nor manure, however well prepared, can prevent, the succession of different kinds of crops has been attended with beneficial results. Thus a green crop, such as grass, turnips, or potatoes, was made to succeed a corn crop; and when this alternation of crops was substituted for a successive series of grain crops, experience soon discovered that less deterioration affected any crop of the series, or the land itself. It was also found, by this arrangement, that a longer period might elapse, than by the former, between the applications of manure, without diminishing the gross produce of the intermediate crops.

In the establishing of this beneficial system of cropping, experience alone has discovered the progressive steps which have led to its completion. The *rationale* of the system has never been inquired into by those who have administered its rules, or been benefited by their application. The investigation of causes is more the duty of the philosopher than of the farmer, who has chiefly to deal with effects; but the happiest results may be anticipated from the combined efforts of both, when the former directs his mind to establish the principles upon which the experienced operations of the latter depend.

It is generally believed that the necessity of a change in the kind of plants cultivated on the same piece of land arises partly from an excretory principle, by which certain substances are given out by their roots and diffused through the soil; and that these excretory substances, although injurious to the plants from which they derive their origin, are supposed to be favourable to the growth of others. It is also believed, and confirmed indeed from the analysis of vegetable substances, that certain kinds of plants deprive the soil of peculiar substances during their development, and that on the presence of these substances in the soil, in certain proportions, the vigour of the plants produced depends; hence, from this it would appear that soils may contain the necessary ingredients for the full maturation of plants of one species, and be entirely unfitted for the production of a crop of a different one; the peculiar principles required in the latter case having been previously abstracted by crops of the same kind.

But, apart from these speculations, there are certain principles by which the farmer must be guided in ascertaining the course of cropping best suited to his land, which are easily understood, and are of universal application. There are also a number of adventitious circumstances which must be kept in view, being likewise deserving of attention. These shall be successively explained.

When a plant is suffered to grow until it has matured its seeds, it exhausts the soil more than when it is removed before its seeds are matured. Plants cut down in their green state, therefore, exhaust the soil less than when they remain until they shall have ripened their seeds. Thus the turnip, as commonly cultivated in this country, is one of the least exhausting in the class of plants to which it belongs; but when allowed to remain in the ground until it has ripened its seeds, it becomes one of the most exhausting plants known. This is indeed evident. In order to bring a plant to entire maturity, by the perfection of its seeds, a larger quantity of the nutrient matter of the soil is extracted by it, than if it were brought only to some of the less advanced stages of its growth.

The cultivated crops may therefore be divided into *exhausting crops*, or those whose consumption makes a comparatively small return towards restoring the fertility of the land which produced them; and *restorative crops*, or those whose consumption makes an adequate return towards restoring the fertility of the land on which they grow. To the first class belong the cereal grasses, and, in a greater or less degree, the cultivated leguminous plants. The cereal grasses are, in an eminent degree, exhausters of the soil, being allowed to fully mature their seeds. The leguminous plants, when cultivated for their seeds, are exhausters, though in a less degree. Hemp and flax, which are cultivated chiefly for their fibres, and all plants cultivated for their oils, are also exhausters of the soil, being allowed to form and ripen their seeds, and their stems affording no return of manure. The restorative crops are those of the cabbage tribe, cultivated for their roots and leaves, as the turnip and rape; also the plants cultivated for their tubers and roots, as the potato, carrot, and beet; and, lastly, those leguminous plants cultivated for forage, as the clover, tare, and others.

Further, some of these crops, from their mode of growth and culture, are more favourable to the growth of weeds than others. The cereal grasses, from growing closely together, and but partially admitting of the eradication of weeds, are more favourable to their growth than such plants as the turnip and potato, which are grown at a considerable distance from one another, and admit of tillage during their growth.

Keeping these principles, which are of universal application, in view, certain rules may be deduced from them to assist the farmer in ascertaining the order in which the plants he cultivates should succeed each other on the same ground.

1. Crops consisting of plants of the same or similar species should not follow in succession, but should recur at as distant intervals as the case will allow.

2. Crops consisting of plants which, in their growth or mode of culture, tend to the production of weeds, should not follow in succession. Crops, therefore, whose culture admits of the destruction of weeds, and crops which favour the production of weeds, should alternate.

3. Crops which, by their consumption, return to the soil a sufficient quantity of manure, should be cultivated at intervals, to maintain or increase the fertility of the farm.*

By the observance of the first of these rules, we guard against the pernicious practice of cultivating several crops of grain in succession —a practice too prevalent in this country, and invariably attended by the deterioration of the soil, in a degree corresponding to the extent to which the practice is carried. Grain crops also favour the production of weeds, by their mode of growth and culture, which do not admit of the extirpation while the crop is on the ground. The second of these rules, then, inculcates the propriety of cultivating, at intervals, such crops as do admit of the eradication of weeds during their growth. Lastly, grain crops, it has been seen, are the most exhausting crops cultivated ; hence the necessity of alternating with them restorative crops, to keep the farm in a due state of fertility, as enjoined by the third rule.

Local circumstances must also be taken into account in determining the particular crops deserving of notice, such as proximity to market, the crops in greatest demand, the nature and condition of the soil, with the facilities for improving it. On a farm previously neglected, crops which make a large return of manure, should occupy a prominent place in the course. Though a diversity of species must be cultivated, yet this may be modified to a certain extent. On land that has been several years in pasture, there may be less necessity for adhering strictly to this rule, although the degeneracy of crops occurring too frequently on the same land, has been very generally acknowledged.

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* Elements of Practical Agriculture, p. 201.

The application of the principles already laid down, will be better understood by referring to some of the courses which experience has shown to combine an abundant produce with the maintenance of the fertility of the soil.

The first of these courses is the four years' course or four-shift, which consists of a regular alternation of the following crops :—

1st year, Turnips, or other green crop, manured.
2nd year, Corn-crop, as wheat, barley, or oats.
3rd year, Grass for soiling and hay.
4th year, Corn-crop.

In this course, each exhausting crop alternates with a restorative one, and one-half of the farm is under exhausting, and the other half under restorative crops.

The soil for this rotation must be of the better class, in order to admit of a continuance of it, otherwise the land cannot be maintained in a due state of fertility, without an extraneous supply of manures. It was first practised in Norfolk, where it has been continued with very little variety during a long series of years, and is now very generally adopted on soils similar to those of that country throughout the United Kingdom. There can be no doubt, that land may be maintained by it in a state of perfect cleanness with regard to weeds, and, when properly managed, it may be rendered more profitable to the farmer than any other. Short and simple as it is, it contains the just elements of good husbandry; but it must be understood, as requiring the whole produce of the cultivated grasses, and green crops, to be consumed upon the farm. Its commencement, in common with that of every judicious course, is founded upon the cleaning of the ground; and there is no crop which, in this respect, presents so many advantagesas the turnip; for the same objects are accomplished by its culture as by a naked fallow upon the heavier soils, while independently of its own value, its beneficial effects extend through the whole course.

It must, however, be remembered, that this course, although forming the best foundation for an established plan, when the soil and the state of the farm will allow, may yet be conveniently departed from on particular occasions. It has this defect, that the crops of the same kind return at too frequent intervals. The soil seems to delight in variety, and so essential is a diversity of plants for the soil, that, under a long continuance of this course, the red clover can scarcely be made to grow. The soil, too, must be of the best description to bear such constant tillage, even with high manuring. In districts in which it has been long practised a very marked falling off in the turnip and clover crops has been observed. So much is this felt, that an occasional fallow has been resorted to, to keep the soil in a full state of productiveness, which it ought to be the object of every farmer to secure; but the object in this case may be much better accomplished by making a deviation from the course as to the frequency of recurrence of the crops. Thus the land may be allowed, for a course of crops, to remain more than one year in grass, or other crops may be substituted for those falling off.

In the vicinity of the metropolis, and in the immediate neighbourhood of some of the larger provincial towns, the following course of cropping is sometimes adopted:—

1st year, Green-crop manured.
2nd year, Corn-crop, generally wheat.
3rd year, Grass, for hay or soiling.

It will be at once perceived, that this course is impracticable unless in the situations already mentioned, where an unlimited supply of manure can be obtained. It is liable, in a great degree, to the same objection as the four years' course, with respect to the too frequent repetition of the same crop on the land. This is remedied, to a certain extent, by the liberal application of organic manures, and by bringing up fresh earth to the surface occasionally in ploughing. A greater amount of produce is, perhaps, obtained by this course, than by any other where it can be adopted. The manured crop consists chiefly of carrots, or potatoes, which find a quick sale in the market. The corn-crop succeeds, which is the least valuable in the course. It is succeeded by a crop of clover and grass, which also meets with a ready sale in its green state, and makes a large return, three cuttings being generally produced in the season. Disposing of the crop in this way is highly improper, unless in cases like the present, where an extraneous supply of manure is easily obtained.

Other courses are founded on the four years' course, simply by prolonging the period, for which the land sown with grass seeds shall remain in grass. When the course is intended to be for five years the crops will be as follow:—

1st year, Turnips, or other green-crop, manured.
2nd year, Corn-crop.
3rd year, Grass for soiling, and hay.
4th year, Grass for pasture.
5th year, Corn-crop.

This course is less severe than the four years' course; and requiring less manure, it is suited to a greater range of soils. In the case of some of the poorer soils a longer rest in grass may be necessary, and with this exception these extended courses do not differ from the five years' course. The full advantage will not be derived from the extension of the course, unless the grass is kept for pasture.

On some of the richer clays and loams a more extended range of the cultivated plants may be produced, the particular plants to be selected depending on local circumstances. The course may then be:—

1st year, Summer-fallow, or green-crop, manured.
2nd year, Wheat.
3rd year, Grass.
4th year, Oats.
5th year, Beans manured.
6th year, Corn-crop, generally wheat.

This course is rendered less severe by allowing the land to remain two years in grass. If manure can be given in the middle of the course, every one of the crops may be expected to be good; but if that is withheld, there will necessarily be a proportionate falling off in the last two crops.

Occasionally two crops are obtained from the land in a season, and various other plants are introduced, which have been intentionally omitted in the preceding courses, as the appropriate place of each plant in the course will be found in the account of its culture; and the object at present is to show, as clearly as possible, the order in which the principal crops should succeed each other, to guide the farmer in devising a suitable course of cropping for his land. When two crops are obtained in the same season, that which is the shortest time on the land is usually called a half or stolen crop. The plants commonly cultivated for this purpose are the tare, turnip, rape, and crimson clover, which are grown on stubble after the removal of the grain crop, when the succeeding crop is to be turnips.

As an example of a regular system of cropping, in which this plan of producing half-crops, as they are termed, is practised, without interfering with the regular produce of the farm, the following course may be cited, as being practised on a large farm of a medium soil, and conducted in the best manner. It is,—

1st year, Wheat, after fallow-crop.

2d year, Tares cut or fed off very early, and afterwards ploughed up for turnips.

3d year, Barley.

4th year, Grass.

5th year, Wheat or oats.

6th year, Pease.

7th year, Tares, rape, or crimson clover, off the land in time for turnips.

8th year, Barley.

9th year, Grass for forage or hay.

10th year, Grass for pasture.

11th year, Corn-crop.

12th year, Rape, or other half-crop, which is to be off the land in the early part of the spring.

By this plan fifteen crops are produced in twelve years, and all of them good, under proper management. The system is extensively practised in the southern counties of England, and although the same success could not be altogether expected to attend it in this country, yet it would be, in most cases, sufficiently remunerating to warrant its adoption. On dry land, good crops of crimson clover may be produced by autumn sowings on the stubble of a corn crop. The crops of turnips and rape might be less productive, but they are raised at a comparatively trifling expense.

These principles and examples are sufficient to illustrate the subject of rotations. They are also applicable to the plants cultivated in this country, and may serve as the basis of other courses in which plants not enumerated here are to be introduced. The system is general in its application, but it is varied by circumstances, so that deviations may be made in certain cases, with the greatest propriety, from the best laid scheme. Observation and experience must guide the farmer in ascertaining the courses best suited to his particular case. Much of the success of any course, however, depends on the manner in which the different processes connected with it are executed; for the best arranged rotation will be of no avail when the processes belonging to it are imperfectly and unseasonably performed. The best farmers avoid over-cropping, or treating land in any way tending to exhaust its productive powers, well knowing the disastrous results that invariably follow.

It has been said, that occasional deviations are sometimes made with the greatest propriety. But should any alteration be desired in the rotation, it can only consist of the substitution of one corn crop for another, or one green crop for another; for the corn and green crops must always stand in the same relative position to each other. This substitution of one crop for another will, however, unless in peculiar cases, be attended with a sensible deterioration in the crop or soil, if the deterioration be not counteracted by an additional quantity of manure. A modification may be effected in the rotation by extending the time which it occupies. But the extension of the length of the rotation must be effected through the green, or restorative crops, and not by the severe, or corn-crops, and that not by means of any of the green crops indiscriminately. Thus the extension must not be effected by a repetition of any of the corn crops, for, it has been already seen, such a proceeding would hasten their own deterioration; nor by adding an alternate green and corn crop to the end of the rotation, for that would be a mere attempt to deteriorate the soil, by delaying the application of manure; nor by repeating the turnip or potato crop, for neither can be raised without manure;—but it must be effected by allowing the land to remain in grass as many years longer as it is desired to extend the term of the rotation. The period for which the land is to remain in grass can alone be extended without impropriety.

There is, however, a limit to the period for which land can be profitably kept in grass. On strong soils, experience has shown that it is inimical to the grass crop to prolong its existence beyond one year; although an extension of the existence of grass on the weaker soils serves to strengthen the energy of the soil. Without the intervention of herbage plants, in due proportion, the extent of land that will bear constant cropping in this country is comparatively small, no matter what applications of manure are made. When land is laid down in grass it is said to *rest*. In order to derive the full benefit of laying down lands to grass, the soil must be previously cleared of weeds, and fertilized by pulverization and the application of manures. When land is laid down to grass in an exhausted state, this process of renovation is slow, if at all perceptible, as the useless plants increase and occupy the place of the more beneficial, and in this case, the object in view is directly frustrated. Under good management, however, laying down land to grass is a means of resting the soil, and renovating its powers of production; and, being always at command, its application is important, and should not be neglected. The poorer class of soils, as has been observed, require this species of rest and renovation more than those which are naturally fertile.

The most important consideration in the cropping of land is to make the crops, termed exhausting and restorative, regularly alternate with each other; and the farmer should not allow any immediate prospect of gain to induce him to follow a course which will ultimately prove inimical to his best interests. It may, indeed, be observed, that all the successful deviations from the alternate system, arising from the more frequent growth of corn than green crops, or the too frequent repetition of any one species, have been either upon rich alluvial earth, or founded upon the application of lime to newly broken-up lands, the powers of which have been forced into action by the stimulus thus occasioned; or, otherwise, by large quantities of animal and vegetable manure, laid on deep, and naturally strong, lands. But, unless under extraordinary circumstances of fertility in the soil, and management in its cultivation, there must be a period beyond which such deviations cannot be advantageously continued; for, where lime has been applied in any considerable quantity, and a course of severe cropping afterwards pursued, the land will become completely exhausted; and dung, if too profusely applied, will injure the quality of the corn, and produce crops more abundant in straw than grain.

Among all the important practices in husbandry, that of a judicious succession of crops is the most important; for, by an attentive adherence to it, the utmost regularity of work will be maintained through every department of labour. To the steady adherence to a fixed system of cropping, are justly ascribed all the improvements in land which have attracted the admiration of every lover of his country; to it is properly attributed the regular apportionment of an invariable extent of land, which is annually devoted to the growth of grain crops; and which regularly checks, as far as human means can, injurious fluctuation in the supply of the first necessary of life; and to it is, accordingly, imputed the supply of the immense numbers of high-fed live-stock which daily grace our markets.

IX.—CULTURE OF THE CEREAL GRASSES.

The crops cultivated in this country, coming under this denomination, are wheat, rye, barley, and oats. These present certain common characters in their habits of growth and modes of culture, which may be considered before we come to treat of the cultivation of each, as much unnecessary repetition will be thereby avoided.

The seeds of plants usually possess such a structure, that only one stem can proceed from each of them; but in the seeds of the cereal grasses, we perceive a remarkable deviation from this state of things. In them, the embryo plant is unusually thickened towards its base, and so organized, that, instead of one stem, three or four often spring from a grain; and, in some cases, the number of stems from a single grain has been so great as almost to exceed belief. Every autumn the public prints contain accounts of the productive powers of the different species of the cultivated cerealia, which, were it not that they are supported by the nature and habits of the plants, would be truly incredible, Amongst others, an account is recorded in the Philosophical Transactions for 1768, from which it appears, that five hundred stems were produced from a single seed, by repeated subdivisions during the growth of the plants.

The seeds of the cereal grasses are sown either in the autumn or in the spring. They are sown broadcast, by scattering them equally over the land, or in drills; or they may be put into the ground by a process termed dibbling, which consists in making holes for the seeds in which they are deposited by the hand.

When sown broadcast, the operation may be performed either by the hand or by a machine for that purpose. In the former case, the grain is contained in a basket or box, supported by straps crossing the shoulders, or in what is termed a sowing sheet, slung over the right shoulder. The sheet is kept distended by the left hand, while the right is used in sowing. The sower walks with a measured step along the ridge, scattering the grain in a uniform manner across it. The process is a difficult one to execute well; and it is impossible, from any description, to form an idea of the measured step, the regular handfuls, and the artificial cast which the sower acquires, and which can be learned only by inspection, imitation, and practice. A skilful and experienced workman regulates the prescribed quantity of seed to the acre with wonderful precision, and distributes the seed over the ground with the most exact equality.

Instead of scattering the seeds by the hand, the broadcast sowing-machine may be employed, which disseminates them with greater regularity, and renders the proper execution of the work less dependent upon the skill and attention of the sower. This machine is drawn by a horse, which walks in the furrows of the field, and it is of a size sufficient to sow the half of two adjoining ridges, or the space of one entire ridge, at a turn.

A man and horse, with this machine, will sow from twenty-five to thirty acres a day. The regular manner in which the seed is disseminated renders less seed necessary than in the common method of sowing by the hand. As regards economy alone, little is gained by the use of this machine—its chief recommendations are the regularity and certainty with which it performs the work, and rendering the execution of it independent of unskilfulness or want of care in the workman.

Whether this machine or hand labour be employed, the harrows are immediately to follow, giving the requisite number of turns lengthwise and across until the seeds are sufficiently covered.

When the grain is to be sown in rows, the sowing machine may move either lengthwise in the direction of the ridges, or across. The distance between the rows may be from nine to twelve inches.

The advantages of drilling are chiefly in the case of the lighter class of soils, and especially where these are apt to be overrun with weeds, the intervals between the rows admitting of tillage during the growth of the crop, by which the weeds are destroyed. These advantages, however, have been magnified to a great extent. So far as regards green-crops, drilling, certainly, is one of the most important improvements of modern agriculture. By no other means yet known can so large a produce be raised off land in constant tillage, so beneficial a rotation of crops be adopted, or so great an economy be practised in the application of manure. But while the advantages resulting from this species of culture, as applicable to our preparatory green-crops, are thus apparent, it does not, in any degree, follow, that advantages equally great will result from its application to corn-crops. The cereal tribe send forth suckers, and the value of the crops mainly depend on the number and vigour of the shoots thus produced. The other kinds of crops do not tiller like wheat, barley, or oats, but rise from one stem. We should therefore infer that the former class of plants ought to be cultivated in that manner in which they are best suited for summer tillage, which is in rows; and the latter in that manner by which the seed is most equally deposited, and best calculated for promoting the process of tillering, which is broadcast. Drilling grain crops has made little progress in this country. It is more frequently practised in England, particularly in the counties of Norfolk, Suffolk, and Sussex; but in Scotland the broadcast system is almost universal.

The period required for the germination of the seed, and the appearance of the crop above ground, is regulated by the season of sowing and state of the weather. The young shoot should rise in a uniform manner, as any irregularity tends to make some future deficiency in the crop. This is more especially the case with spring-sown corn than with that which is sown in the autumn, the plants of the latter acquiring an apparent equality, while those of the former always maintain their disparity. The young plants should be of a dark-coloured hue, and the first leaves which are formed should be short, thick, and not sharply pointed, but firm and elastic; those of wheat approaching to a tinge of brown; rye brown, drawing towards red; and those of all spring corn of a deep green, without any intermixture of yellow. The latter colour usually indicates the presence of some disease, from which the plants rarely recover.

The autumn sowings reach the winter season at various stages of their growth; but although their progress may be checked by severe cold, it is never entirely destroyed, and vegetation is renewed with increased vigour when the weather becomes open in the spring. Thus, in very long-continued frosts, which have penetrated deeper into the ground than the roots, the plants have tillered with extraordinary vigour in the ensuing spring, and the sharpest winters have often been productive of the most abundant crops. Those winters which are in this country termed mild, and which constantly occasion alternate changes of weather, are far more dangerous to vegetation, especially upon wet soils.

Before the grain shoots, as in the month of June, the large weeds are to be pulled up to prevent them from running to seed and interrupting the operations of the harvest. When the row-culture is adopted, the crop may be hoed, and when the seeds of the clover and grasses are to be sown the operation should take place immediately before hoeing, the loosening of the earth during that process affording an ample covering for the smaller seeds.

The time of flowering is a critical period in the growth of grain crops. If the weather continue long wet, vegetation proceeds imperfectly; but if the month of June be dry and warm, with only occasional showers of rain, it is propitious. This is also the time when there is the greatest danger of the crop being laid. If this happen before the process of flowering is completed, through the effects of storms, it occasions no great mischief, for the plants soon recover their original position; but it is very prejudicial if it be caused by their apparent weight and richness, for that is frequently the consequence of weakness in the stems, and a general failure in the quality of the plants, occasioned by defective tillage, injudicious application of manure, or by growing in a sheltered situation.

When the proper time for commencing the operations of harvest arrives, the crop is cut down, either by mowing with the scythe, or reaping with the sickle; for although machines have been invented for the performance of the operation, they are far from being generally employed even in those countries in which they have been invented, and are almost unknown in this country, except by report. After remaining a sufficient time in the field the grain is stacked, and afterwards thrashed out, either by the manual labour of the flail, or by means of the thrashing machine; and after being winnowed, to divest the grain of its husk, it is ground into meal or flour, or otherwise disposed of, according to the various uses to which the different species are applied.

The period at which corn-crops should be cut down is indicated by the green colour of the stem disappearing, and the grain becoming hardened. In the cereal grasses the seeds in the upper extremity of the panicle become ripe before the others, and when the uppermost grain has dropped out, the crop has stood too long. The practice of the best farmers is to reap their grain crops before they come to a state of extreme ripeness, as the hazard from winds and rains is thereby diminished, as well as the loss from the shedding of the grain during the reaping and removing of it.

The state of the straw is the chief criterion to judge by in ascertaining when the crop is ripe. It will then be of a bright yellow colour, and the ear will begin to hang down. It is, however, necessary to discriminate between the ripeness of the straw and that of the grain ; for in some seasons the straw ripens upwards ; and in this case a field may appear to the eye to be ready for cutting down, when in reality, the grain is but imperfectly consolidated, and perhaps not much removed from a milky state. Though it is obvious that, under such circumstances, no further benefit can be conveyed from the root, yet it does not follow that grain so situated should be cut down ; because, after that operation is performed, it is in a great measure deprived of every benefit from the sun and air, both of which have greater influence in bringing the crop to maturity so long as it remains on foot than after it is cut down, whether it be laid on the ground or bound up into sheaves. The state of the weather also deserves notice ; for in moist, or even variable weather, every kind of grain, when cut prematurely, is more exposed to damage than when completely ripened.

The usual mode of cutting down the crop is with the sickle. It is either smooth-edged or serrated, but the former is to be preferred. The reapers commence at one end of the field, and being arranged in twos or threes on each ridge, according to the breadth of the ridge, they proceed in the direction the crop inclines to, and never in the contrary direction. One binder follows for every six reapers, whose duty is to bind and stook the crop, and see that the reapers cut it down properly, and lay it in the sheaves with neatness and regularity. The binder, having bound up the sheaves, places them upon every alternate ridge, resting upon their bases, and upon one another. Five pairs of these sheaves, when the crop is oats or barley, and six pairs when it is wheat, may be conveniently placed together in rows. The sheaves are placed in such a manner as to be in contact at the top, though, in order to admit the circulation of air, and render the grain less liable to be overturned by winds, they are placed at some distance at the bottom; and the whole is covered by two sheaves, the butt ends of which lie towards each other, with the other ends divided a little, and pulled down so as to defend the upright sheaves. The stooks should be set nearly north and south, so as to be equally dried by the sun on both sides.

Cutting down the crop in a wet state should be avoided as much as possible, for, when put into a close sheaf in a damp state, it is long in getting dry. It is often, however, necessary to reap it in a moist state. Instead of the usual method of binding and stooking, the sheaves may be set up single, and loosely tied near the ear ends, so that the bottom may be stretched out, and each sheaf made to stand separately upon its own base. This process is termed *gaiting*. A readier access is thus afforded to the air, and the crop dries sooner. Before the gaits are removed from the field, they ought to be bound tightly together the same as the others, and carried at once to the stackyard, or placed in stooks until it is convenient to remove them.

Gaiting is to be recommended, then, in an unfavourable harvest, when the crop is wet at the time of reaping, and little prospect of its soon becoming dried. But even in the most favourable weather there will be times at which it would be exceeding imprudent to bind up and stook the grain, though it may be proper to cut it down. This occurs when there are heavy dews in the mornings, by which the crop is quite wet, and these disappear as the day advances. In this case gaiting would be unnecessary, as the grain will be dried in a few hours by being laid spread across the band which is to bind it up. If there is any probability of unfavourable weather ensuing, it is, however, bad management to have any part of the crop exposed in this way, as it is often a work of great labour to get it dried and bound up into sheaves.

The sickle was formerly the only instrument employed in cutting down grain crops; but of late the scythe has come very much into use, and seems to be gaining ground for cutting down every kind of corn, except when the crop happens to be very much laid, or the ground very rough and uneven. In England and Scotland reaping with the scythe has long been becoming more general, although it is but little practised in this country owing chiefly to the greater number of hands which can be procured for carrying on the harvest work.

We shall therefore give a detailed account of the construction of the instrument and mode of operation.

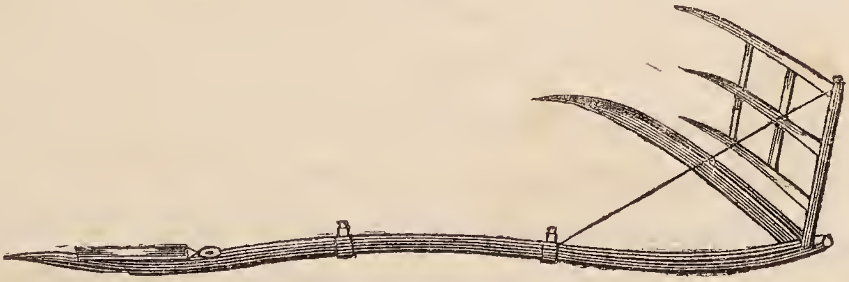
The scythe employed in reaping corn requires more nicety in the construction of its several parts than one for common purposes. The blade should be of patent steel, strengthened by a plate of iron along the back; and its temper should not be too hard, which can be determined by examining closely the edge of the blade, and observing that it is smooth and not serrated. A good mower always prefers a long blade, more than four feet in length. The handle or sned should always be straight; the curved form may seem more convenient to the hand, but as the line of draught must always be straight, the straight sned invariably gives the greatest command over the scythe.

To gather the corn and lay it down in a regular swathe when cut, a simple apparatus called a rake or cradle is attached to the scythe. This rake, as its name implies, consists of three long teeth, diminishing from the uppermost to the undermost, fastened to an upright stem, and strengthened by a rod passing through them parallel to the stem. It should be made of the finest ash, and as light as the strength of the wood permits. The upper tooth should be two feet or a little more in length, and that of the other two each three inches shorter than the one above it; and all of them curved similarly to the back of the scythe. The stem of the rake is driven into a socket of iron, having a wedge-shaped toe placed at right angles to it in the direction of the teeth of the rake. It is fastened to the sned, so as to stand in a perpendicular position when the scythe is to be used, being secured with the same iron ring and wedges which fasten the blade and the handle together. The rake stands with the socket about thirteen inches in height, and the spaces between the teeth, and the undermost tooth and the blade of the scythe, are about four inches. The adjustment of the scythe consists in placing the blade in such a position that its point shall be as far from the handle by which the mower supports the scythe in his right hand, as the length of the blade itself, and as this handle is from the butt end of the blade. In short, the lines connecting the butt end, the point of the blade, and the right-hand handle, should form the sides of an equilateral triangle. The edge of the blade for reaping should not be so low set as that of the scythe which gardeners use for cutting grass walks, nor so high as that for the cutting of clover. A strong cord is requisite from the stem in which the teeth of the rake are fastened, to a nail in the sned, a little below the right-hand handle, to serve the double purpose of keeping the rake in a desired position, and of laying the corn over in the swathe. Thus equipped, the reaping-scythe should balance itself exactly on both sides of the right-hand handle.

When the crop is light, a still more simple appendage to the scythe may be used. This consists of a small rod or shoot, nearly an inch in diameter, of green willow, hazel, mountain ash, broom, or any other tough and flexible young wood. It has its thick end twisted into the small iron rod, which aids in attaching the blade of the scythe to its handle, technically termed the grass-nail. Its small end passes over the upper side of the blade as far as the back, when it is bent upwards in an easy curve, and is brought backward and fastened to the handle at about fifteen inches above the blade.

The relation of these minutiæ will not, we hope, be considered tedious, for upon the proper adjustment of the scythe depends, in a great measure, the success of reaping the corn neatly and quickly. The annexed figure represents a mounted scythe ready for work, in the position in which it is used. It will make the foregoing description easily understood.

Fig. 68.



The best position of the corn for reaping with the scythe is the upright, or a little swayed, either naturally or by the wind, from the mower. The best direction in respect to the ridges is across, as the ground is then always straight for the stroke of the scythe, and the furrows of the ridges are easily cleared. In commencing to reap a field of corn, a little consideration is requisite. The general position of the corn over the whole field must first be considered, then the quarter from which the wind blows, and, lastly, the direction of the ridges. If all are favourable, the work will proceed cheerfully; if not, a compromise must be made with the opponent. The wind must always be in the back or on the right hand of the mower, for a strong wind will sometimes overrule the natural position of the corn; and a diagonal direction across the ridges should always be preferred to one along them. At whichsoever side of the field operations are to commence, that side must be entirely opened up by cutting down a breadth of corn in the line of the ridges, equal to the whole band of mowers, which gives access either across, or in a diagonal direction over the ridges.

To carry on the reaping in a regular manner, it is necessary to arrange the mowers into bands of two each, according to their ability, that each may be equally dexterous. Every band may be arranged in this manner: two scythe-men to reap; a person, generally a woman, to follow each scythe, to make bands and take up the corn, and place it in the bands ready to be bound up; a bandster, always a man, follows the woman and binds up the sheaves; the two bandsters set up the corn together into stooks; a woman follows the whole with a large rake, and clears the ground of any loose corn, and brings the rakings to the bandsters, to be bound up in the sheaves, or by themselves.

To ensure good work in reaping with the scythe, it is requisite to preserve a keen edge on the blade, and always keep the heel of the scythe close to the ground. The keen edge is best preserved by a broad cannel, or chamfer, on the upper edge of the blade, and a narrow one below; and the scythe should be sharpened by always moving the hone, or whetstone, from the heel to the point; because the straw is cut by moving the scythe from the point to the heel. Many able mowers cannot preserve a keen edge on their scythes, because they are not aware of the necessity of attending to the difference of the chamfers on the upper and under edges of the blade, and through this ignorance, they move the hone, or the whetstone, both up and down the blade, thereby counteracting, with one stroke, the good effects of the previous one. The hone, if kept dry, will always preserve a keen edge on the scythe, with the assistance of the whetstone once or twice a-day. It is good work to cut constantly a width of seven feet and a half, and from ten inches to a foot in breadth at every stroke, and a swathe of this description sixty yards in length may be cut after every sharpening.

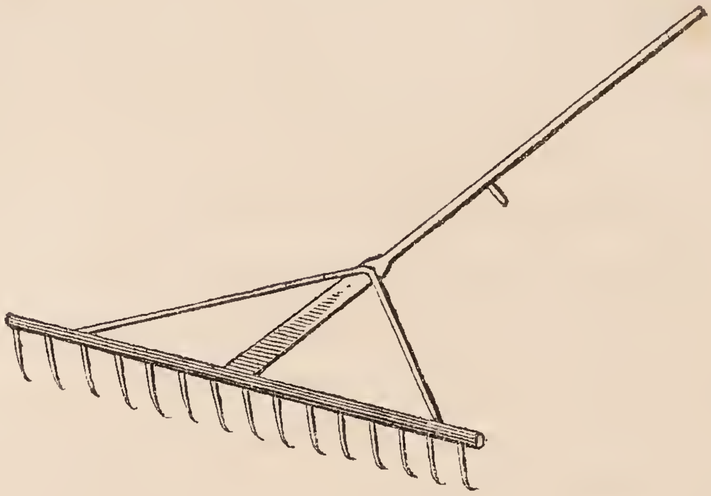
The rake attached to the scythe requires a position varying with the nature of the crop. When the crop is an average one, it should be placed in a line with the back of the blade of the scythe; when a strong one, it should be kept within the blade; and when a thin one, it should project a little beyond the blade. These necessary changes in the position of the rake for collecting the severed corn in a proper manner, show the propriety of appending it in such a way that they can be made with little delay. The momentum acquired by the scythe, carries round the dissevered corn, and the cord, or other fastening, which stretches from the rake to the sned, directs the fall of corn into the swathe. The stems of the grain should be parallel to one another in the swathe, and the direction of the swathe should be at right angles to the line of the mowers.

The corn from the swathe must be carefully placed in the bands; and if any of the straw is, by accident, disarranged by the scythe, it should be adjusted. The taker-up must also be careful in placing the bundles of corn square upon the bands, so that the sheaves should be balanced when tied. Inattention to this necessary arrangement may not only cause much hindrance to the bandster in its adjustment, but trouble to the person who forks the sheaves into the carts which convey them to the stack-yard. Each taker-up may make bands to herself from the loose corn, as they are required; but as this operation would be rather too tedious at that time, it is advisable for the takers-up, and the bandsters together, to make a sufficient number of bands from the loose corn when the mowers are sharpening their scythes, and lay them down regularly near that side of the standing corn which is to be next cut. With a good crop, the mowers will keep the persons taking up the grain, and the bandsters, hard at work, with their best exertions and happiest expedients.

The raking process cannot be performed sufficiently expeditious by a common hay rake. The head of the corn rake should be made of fine ash, as light as possible, but strong enough to bear the driving in of a number of iron teeth; and it should be, at least, five feet in length, and feruled with iron at both ends. The teeth should be seven inches in length, and four inches apart, and so curved at their points, that the weight of the stem may rest upon the curve, with their points free of the ground when the rake is held in a working position.

The duty of the raker is to clear the ground passed over by the bandsters, and to bring the rakings quickly up to them. The rakings are most easily got rid of by pushing the rake, with both hands, backwards, in nearly a horizontal position. The labour of raking depends altogether upon the state of the crop. The straw of a good crop adheres together, and, of course, little of it is left to be raked; but a scanty crop produces abundance of rakings. Barley generally leaves more rakings than any other kind of crop. It is more difficult to rake upon new grass, such as in reaping wheat and barley, than on a clean stubble, as of oats.

Fig. 69.



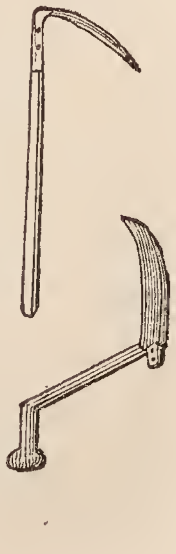
Corn of every description may be reaped with the scythe. Oats make the most perfect work, with the greatest ease to the labourers. Barley with new grass is not difficult to cut, but the clammy juice from the barley straw lubricates the scythe with a viscid coating like varnish, which must be rubbed off frequently with the whetstone. The bandsters have always hard work among barley. Wheat is beautifully laid in the swathe when mown. The gatherers and binders have less work among wheat than the mowers, who must be powerful men to continue a length of time at the work. But there are modes of equallizing the labour and diminishing the fatigue. When a field of wheat and a field of oats, for instance, are ready for reaping at the same time, it is a good arrangement of labour to reap the oats in the dewy mornings before breakfast, or as long as there is any dampness on the corn, and then to go to the wheat, or to the barley, if there be little wheat on the farm, during the dry part of the day.

It will be seen, from the foregoing account of scythe-reaping, that the corn is cut from, and not towards, the standing part of the field, as in the case of cutting down grass; but it is also frequently cut in the contrary direction, that is, cut towards the standing part of the field, and, with inexperienced mowers, the latter plan is generally preferred. The swathe then rests upon the standing corn, off which it is carefully lifted immediately out of the way of the mower who follows.

Corn mown by the scythe is cut closer to the ground than when reaped by the sickle, and the stems being less compressed together, the crop is sooner ready for being carried to the stack, which is an important consideration in our variable climate. The sickle excels the scythe in this, that the corn is laid down more regularly, with the heads in one direction, especially when the crop has been much tossed and broken down by the wind. In this case, indeed, the use of the scythe is almost inadmissible. As far as regards economy alone in cutting down the crop, there is not so much gained by the use of the scythe as at first sight might appear; but, however trifling it may be in the cutting down of an acre, or other small quantity, when performed on a more extended scale, it will become worthy of attention. A set of reapers, with their binder, containing in all seven persons, will reap an acre and a half in a day; and a set of mowers, containing three scythe-men, three gatherers, three binders, and a raker, will cut down four acres and a half; but mowing grain being so much severer work than any other operation of the harvest, the men employed at it must have more than the usual rate of wages. The great advantage of the scythe, however, consists in the expedition with which the work is performed, which is an important consideration when a large quantity of grain is ready for being cut down, as it renders the farmer, in a great measure, independent of the assistance of any others, except those constantly employed on the farm.*

Another instrument used in reaping, and much prized for the regularity with which it lays down the reaped corn, is the Hainault scythe. With this instrument in his right hand, and a bent hook in his left, the workman cuts down the grain, pressing it with the hook while it is cut down with the scythe. The quantity cut at every stroke is carried forward by the joint operation of the blade and the hook, and collected at the left hand of the mower, where he leaves it standing almost erect, but leaning to the left, towards the uncut corn.

Fig. 70.



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* Quarterly Journal of Agriculture, vol. iv.

This is a very useful implement in Flemish husbandry, and in the hands of an experienced person will cut a third more corn in the same time than can be done with the reaping hook. The blade is broad and about twenty inches long; and the handle is about the same length, and fixed so as to form an acute angle with the blade, when in the act of cutting. It is so constructed that when the blade lies flat on the ground, the hand of the operator is nearly perpendicular over the curve of the blade, so that he can swing the instrument, by a motion of the wrist, without stooping. A leather strap, doubled and nailed on the handle, in which he puts the four finger, prevents its slipping from his grasp. The bent hook held in the left hand is three feet long, having the curved part of iron. The cut corn is laid against that which is standing until as much is cut as will make half a sheaf, when the workman turns half round, and hooking up part of what is cut with as much of what is standing, he cuts and rolls up the whole in the form of a sheaf, using his leg and foot to keep it in the bend of the blade, the leg being protected by a piece of strong leather. Repeated attempts have been made to introduce this excellent implement in this country, without much success, even though several Flemings have been brought over to teach our workmen the use of it.

After remaining a sufficient length of time in the fields to be perfectly dried, the crop is conveyed from the field to the stack-yard. When it is fully ready for the stack no opportunity of conveying it there is to be neglected, but it must not be stacked before it is fully ready, otherwise the mass will ferment in the stack, and be thereby much injured.

Unceasing activity and the most minute personal superintendance are indispensable at that critical period when the labours of the harvest are going on. Some farmers, have rarely, if ever, any damaged grain in their possession, while others, of more tardy habits, are seldom without it. A disposition to trifle or procrastinate, and to rely on the continuance of fine weather, is quite unbecoming the character of an industrious and intelligent farmer; and there cannot be a better criterion to judge of the agricultural skill and enterprise of any particular district, than to ascertain how the labours of the harvest are conducted.

The grain being ready, it is formed into stacks as a defence against the weather. These are either circular or oblong, but the circular form is to be preferred, as being more convenient, and better adapted for early stacking in wet seasons. They should not be made too large, for, in this case, there is greater difficulty in securing the grain.

In stacking, there is seldom more than one person employed in managing the work; but it is occasionally necessary to have a boy to receive the sheaves from the person forking them up, and to hand them to the man building the stack. In executing the work, the centre of the stack is to be kept somewhat raised above the sides, by which the grain is secured from the entrance of external moisture. The workman begins in the middle of the stand, by placing a sheaf in an upright position, round which he places other sheaves on their butt ends, with their tops inclining inwards, till he comes to the outside, where he carries a row of sheaves quite round, in a more horizontal direction than the preceding courses. The bottom of the stack being formed, the outside rows are continued until the whole is raised nearly to the same height as the tops of the upright sheaves before mentioned. An inner course is now laid all round with the butts of the sheaves, fifteen or eighteen inches further back than those of the outer course; and, if the stack be of large dimensions, similar courses are laid, each being a little within the preceding one, till the centre of it is filled up. The work proceeds in this manner, placing alternate layers outside and inside, until the stem is completed, when the last outside row of sheaves is placed a little further out than the others, in order to form a sort of projection for the eaves, that the water may be thrown off more effectually. The roof is formed by placing each successive course of sheaves a little more inwards, always observing to keep the centre of the stack a little more elevated than the outside. When the top is thus brought to a platform of three or four feet in diameter, according to the size and length of the sheaves, a sheaf is placed in an upright position in the centre, and surrounded with others standing in like manner upright, but with their tops inclining inwards, and leaning on the centre sheaf. These upright sheaves are bound round with a few turns of a straw rope, the ends of which are fastened to opposite sides of the stack, to prevent them from being blown down until the stack is thatched.

The stack usually increases a little in diameter from the bottom to the eaves, but this deviation from the perpendicular should be very slight, as it tends to render the stack more apt to incline to one side.

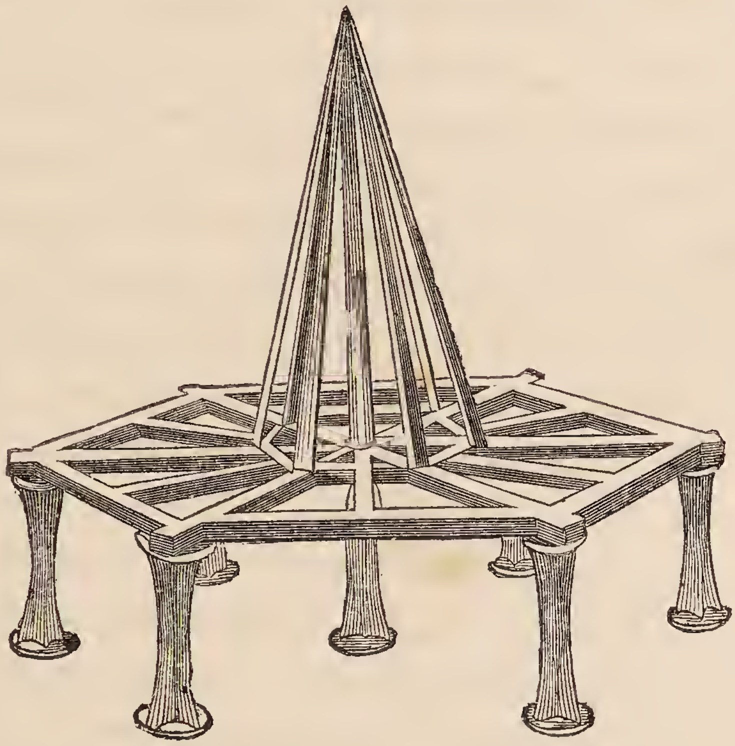
The stem should contain about two-thirds and the roof one-third of the whole stack.

When the farm-servants are employed at harvest work, a certain number of them must constitute a band by themselves, in order to carry on the leading-in of the corn when it is ready to be stacked. A man attends in the field to fork the sheaves into the carts, and to tie the ropes when the load is finished; and a woman is employed in selecting out such sheaves as may be too damp, and to have them opened out during the day; and also in gathering up any stalks that may be on the ground occupied by the stooks. Another man is employed in the stackyard, trimming the stack, arranging new stands, commencing a new one when the stacker is finishing the top of the old, and handing the sheaves forward to the stacker on the top of the stack when it becomes so elevated as to interfere with the drivers throwing the sheaves off the fork from the cart. The extra man in the stack-yard, assisting the stacker, will be found to be no supernumerary, as much time would be lost without his assistance.

After the stack has subsided a little, it is to be thatched. In thatching, the workman begins at the eave, and lays the straw in regular breadths until he reaches the top, the different handfuls being so placed as to overlap each other, and the upper ends being pushed a little into the butts of the sheaves in the stack. In this manner he gradually proceeds, until the whole of the roof is covered. The thatch is then fastened down by straw ropes, which are made at intervals during the harvest, when the state of the weather does not permit the other harvesting operations to be carried on.

Stacks are sometimes placed on the ground, the only preparation under them being a circular layer of stones, and a slight covering of straw; but raised stands are to be preferred, as they not only admit of the corn being stacked sooner by the free access of air, but also prevent in a great measure the introduction of vermin into the stack. They consist for the most part of a circular frame of wood supported by cast-iron pillars, seven of which are required for each stack. On these stands upright posts are placed at the distance of about two feet from the centre, and inclining inwards to the top, where they are not more than a foot distant from the centre post. A few spars of fir or other wood are nailed to the upright posts, so close as to prevent the sheaves from filling up the open space in the centre of the stack. In building the stack, the butts of the sheaves are placed against the upright posts, until they reach the top of them, on which a barrel or bag, well filled with straw, is placed, around which the building of the stack continues, the barrel or bag being pulled up occasionally; and in this manner the work proceeds to near the top of the stack. This opening serves to ventilate the stack, and prevents it from heating even when the corn is carried to it in a damp state.

Fig. 71.



The corn now remains secure in the stack-yard until it is required to be thrashed for use. The mode of thrashing is either by the flail or thrashing machine. The machine is of course inadmissible in the case of small farms, but wherever there is any considerable quantity to thrash, it ought to be employed. By means of it the farmer is enabled to have his work performed at once, and take advantage of the fluctuations in the market in the disposal of his grain.

Thrashing machines have usually a set of fanners attached to them, and those on the largest scale are sometimes provided with a second set, by which the cleaning of the grain is rendered so complete as to require little or no dressing afterwards. From the inequality of motion, however, necessarily attendant on so violent an operation as that of thrashing, and the additional strength required, which is severe on horses when they are employed, the second set of fanners is now generally laid aside; the judicious farmer, who wishes to secure at market a character for well-dressed grain, finding it more for his interest to give the final dressing to it by a winnowing machine turned by the hand.

Besides passing through the riddles placed in the winnowing machine, the grain is to undergo another riddling by the hand before it is thoroughly cleaned. For this purpose the person who takes it away from the machine supplies those who are to riddle it, with the grain in proper quantities, two riddlers being generally required to riddle the grain as fast as it comes from the winnowing machine. This is one of the most important of the manual operations in the preparation of grain. It takes out all the heavy heads of weeds, short bits of straw, small stones, lumps of earth, and grain enclosed in the capsule which the blast generated by the winnowing machine was not sufficiently strong to blow away.

The light grain separated in the process of winnowing, and that separated by the hand-riddling, is to be again passed through the machine and riddled till all the heavy grain is separated from the light; and the latter, after it being freed from its impurities of sand, small seeds of weeds, and husks, is placed apart for feeding poultry or other purposes. In the case of wheat, the lighter grain may be ground into meal, in which state it is used for various purposes in domestic economy.

The thorough dressing of grain, and making the whole stock correspond with the sample produced at market, are important objects for the farmer to attend to. In this way all disputes with purchasers are avoided, and the grain brings its full value. One or two per cent. of bad grain left in the parcel will often lessen the price from five to ten per cent. The inferior grain, when dressed out, may be sold separately, or otherwise used at home, where it will be got rid of to greater advantage.

The grain being thrashed and winnowed, the common practice is to convey it as quickly as possible to the miller or intermediate dealer in corn, reserving of course, the portion required for home consumption. Sometimes the grain is removed to granaries, and spread upon the floor until it is required for use. If at all moist, it must be spread very thinly over the floor of the granary, and repeatedly turned to prevent it from heating, which it would certainly do if put together in any considerable quantity in a moist state.

The straw is used for various purposes, but its main consumption upon the farm is for provender and litter. The quantity produced varies greatly. It may be held, on a medium, to weigh from two to three tons per acre. Wheat produces the greatest weight, oats the next, and barley the smallest, as well as the least valued for its quality.*

Having thus treated of the cereal grasses in so far as they present common characters, we now come to consider the characters, uses, and modes of culture of each. They are divided into genera, in common with the whole vegetable kingdom, and these again into species, and minor varieties, or kinds.

I.—WHEAT.

Wheat is by far the most important of the cultivated cerealia, whether we regard the quantity and value of its produce to the farmer, or the many and important uses to which it is applied in the baking, culinary, and confectionary arts. Of what country wheat is a native is totally unknown, although its culture forms an important part of the labours of the husbandman in all temperate climates.

Botanists reckon upwards of twenty species of the genus *Triticum*, the greater number of which are said to be deserving of attention as objects of culture; but of this number very few have as yet been extensively cultivated, and many of the others are probably altogether undeserving of attention, being merely found in botanical collections.

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* The following table exhibits the nutritive products of the plants to be treated of in this section in 1000 parts.

Name.	Soluble or nutritive Matter.	Mucilage or Starch.	Saccharine Matter.	Gluten or Albumen.
Wheat	955	760	—	210
Rye	810	650	35	110
Barley	920	790	70	60
Oats	740	640	15	90

Of the species that have entered largely into cultivation may be enumerated—

1. Triticum sativum—Common cultivated wheat.
2. Triticum turgidum—Turgid wheat.
3. Triticum spelta—Spelt wheat.

Triticum sativum includes the varieties belonging to the species, hybernum and æstivium, or winter and summer wheats. It is conceived that the differences between these varieties do not constitute a specific distinction, and for this reason the term sativum has been employed.* The chief distinguishing character between them consists in the varieties of the former being beardless, or nearly so, while the awns of the latter are generally two, three, or more inches in length; but it is an established fact that awns, or beards, in grasses do not even constitute a variety, so much does their presence or absence depend upon the effects of climate, culture, and soil. The varieties of *T. sativum* vary greatly in their external characters and habits of growth. Some of them are so early that the crop will come to maturity, even in this humid and variable climate, when sown so late as April or May.

In *Triticum turgidum* the spike is usually bearded, but in some of the varieties the beards, or awns, are easily detached by winds when fully ripe, which gives them a beardless appearance, and in this respect it differs from summer wheat. The turgid wheats are generally hardy, vigorous, and very productive; having long, hard, and almost solid straw, so coarse in quality as to be disliked by cattle. When, however, thatch is reckoned an article of importance, no sort could be cultivated to greater advantage, provided the soil and climate are suitable. The soils best adapted for the growth of the turgid wheats, are those of a strong rich clayey or tenacious nature; and such as the common wheats are apt to become lodged in, the strong straw of the sturgid wheats, notwithstanding the heaviness of their ears, being fully capable of standing under any ordinary circumstances. On such soils they are extensively cultivated in England; but, as they belong to the latest class of winter wheats, they are only adapted for earlier climates.

The next species, *Triticum spelta*, spelt wheat, is much cultivated in the south of Europe. It is distinguished by the grain adhering closely to the stem, and by its being closely enveloped by the husk from which it is difficult to separate it. It might be raised in this country with facility, and has been, in some instances, successfully produced at great elevations.

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* Lawson's Agriculturist's Manual, p. 2.

The different varieties of *Triticum sativum* are those which are almost exclusively cultivated in this country, and may of course be regarded as greatly the most important to the husbandman. They are exceedingly numerous, and to attempt to point out such marked distinctions as would make each variety known, would be a hopeless task, for the shades of difference are in most cases so small, that one might easily be mistaken for another. They are also constantly changing, and losing their distinctive characters. No sub-variety ever continues long in vogue; nor is it fitting that it should, as degeneracy soon takes place, and another and a better is sought for as a successor.

Though the varieties and sub-varieties of this species are so numerous, the only important division to the farmer is that into white and red—distinctions which are permanent and well-defined.

The red wheat is usually grown upon the strongest clay land, and degenerates when sown upon a soil of a lighter description. It is of various shades of a reddish-brown or deep yellow tinge, and generally retains the same hue, whatever may be the quality of the ground on which it is produced. The outer husk is coarse in proportion to the humidity of the soil, and consequently lowers the value of the grain; which, accordingly bears a price in the market of from twelve to fifteen per cent. less than fine qualities of the white. It is, however, so hardy, and so much better adapted to ensure the production of a crop on wet and adhesive soils, that it is very generally sown on land of that description; but, on all the better class of soils, the white or smooth-chaffed wheat is preferred, from the thinness of the husk rendering it more profitable to the miller. The minor varieties of the red and white wheats are known by denominations given to them in consequence of some supposed existing shade of difference in their qualities, or from some local circumstance arising either from the place of their growth, or the name of the grower.

Winter wheat is sometimes confounded with spring wheat, the only distinction being in the different periods of ripening. The produce of wheat sown in the spring acquires the habit of ripening earlier than the produce of that sown in autumn; hence the farmer, when he sows wheat in spring, should sow the produce of that which had been already sown in spring, and not the produce of that which had been sown in autumn. This distinction is not, however, permanent, for the one can be changed into the other by the common means of culture.

The soils best adapted for the culture of wheat are the rich clays and heavy loams; but these are not by any means the only descriptions of soils on which it may be cultivated. Before the introduction of turnips and clover, all soils but little adhesive were thought unfit for wheat; but even on sandy soils it is now extensively cultivated, after either of these crops. Such soils are not, however, constitutionally disposed to the growth of wheat; nor will they, under any management, bear such a frequent repetition of it as those already mentioned. Wheat, in this country, does not admit of being cultivated at a great elevation, but it will endure a great deal of cold during the winter without injury, if sown on a dry or well-drained soil. To bring wheat to perfection, a dry and warm season is required for the blossoming of the ear, and ripening of the grain. Cold, even unaccompanied by rain, at this season, produces an inferior description of grain greatly deficient in gluten.

The season of sowing wheat depends on the crop to which it succeeds. It is sown before winter, when the land can be then prepared for its reception, as after fallow or potatoes; and it is sown in spring after turnips, cabbages, and such other crops as are not removed off the land till that season.

The time of sowing must depend on the state of the land, as well as the season. It is, however, generally recommended, to put it into the ground as early as may be convenient in autumn, and, on strong soils, it is not unfrequently sown in the latter end of September, though more usually in the course of October and beginning of November. When wheat succeeds turnips it is, indeed, sown by many farmers at intervals throughout the winter, according as the land is cleared, until the middle of March; but, when deferred till that period, the seed chosen should be the produce of that which was sown in spring. Early sowing is to be recommended, for late-sown wheats are more liable to become mildewed; and even should they escape that disease, yet if the season proves unfavourable they will not ripen so soon, by many days, as that which is sown earlier; and every experienced farmer well knows the importance to be attached to this circumstance in an unfavourable harvest.

The order in which wheat occurs in the rotation is after summer-fallow, or what are usually termed fallow-crops. It is sometimes sown upon clover ley, but, unless under peculiar circumstances, this cannot be regarded as the proper place for wheat in rotation. Though wheat requires a rich soil, the direct application of manure to the crop cannot, in general, be recommended, as it is productive of an increase of straw rather than of grain. It is therefore better that the manure should be applied to the preceding crop, and in practice this is usually the case.

When wheat succeeds a green crop, a single ploughing, usually termed the seed-furrow, is the only preparation before sowing. Before this is given it is advantageous to cross-harrow the land, which levels the drills, and permits the ploughing process to be carried on with precision. Almost in every case the ridges should be gathered up so that the furrows may be well cleared out, and the plants preserved from injury during the inclement season of winter. Clover land intended for wheat should be neatly ploughed and well laid over, so that the roots of the grasses may be buried and destroyed; for it frequently happens that crops of wheat, after clover, are greatly injured by inattention to the ploughing process. It is likewise of importance that the clover leys should be early ploughed, that it may have time to consolidate, otherwise it is likely to throw out the young plants of wheat after winter frosts. Indeed, sowing wheat after clover may be considered as the most hazardous way in which that crop is cultivated.

Seed wheat is prepared by a process peculiar to itself, termed *pickling*, before being sown. This is intended to prevent smut, a disease to which all the species of the genus Triticum are subject. The nature and origin of this disease, as well as the mode of action of the pickle in preventing it, are, to a certain extent, involved in obscurity, although all practical farmers are unanimous as to the propriety of pickling as a preventative. Various substances are employed as a pickle to wash the seed; but a solution of common salt in water, sufficiently strong to buoy up a fresh egg, has been proved to be as effective as any other, and being at all times easily procured, it is to be preferred.

In the process of pickling a tub is to be provided, and partly filled with the pickle, and a portion of the wheat to be pickled put into it, and well stirred for a few minutes, so that the lighter grains may come to the top. The successive portions of the wheat are to be thus treated until all is pickled, taking care to remove all the light grains from the surface of the pickle before taking the wheat out of it. After draining for a few minutes, to allow the moisture to escape from it, it is to spread in thin layers on the barn floor, hot lime being sifted upon each layer. It is of importance that the lime should be hot, the immediate object in its application being to dry the wheat so that it may not adhere together in sowing.

The wheat should not be pickled until immediately before sowing, for if kept long after that process its vegetative powers may be injured. If from any cause, as by the intervention of rain, it be impracticable to have it sown for a day or two after pickling, it should be spread thinly over the floor to keep it from heating.

When the seed is sown broadcast it is covered by the action of the harrows. No more harrowing should be given than is necessary to cover the seed, it being better, in the case of wheat, that there be a certain roughness of clod; besides, the land suffers severely during the winter from an excess of harrowing, especially if it be incumbent on a retentive bottom. As to the precise quantity necessary, none can give an opinion, except those who are present. A double turn along the ridge, a double turn across, and again a single turn along, will, in almost every case, suffice; and often less, as a double turn along, and a single turn across, and, perhaps, in some cases, the turn across may be dispensed with.

Immediately after the seed being harrowed in, the whole is to be water-furrowed to carry off all excess of moisture off the land. This is done by the double mould-board plough, with one horse, passing along the furrows of the field, and also along the furrows of the head-lands. Open furrows are also to be drawn through such hollow parts as the water might stagnate in, and these are to be further cleared out by a person following with the spade, taking care to sink all inequalities that a passage may afforded for the water to run off. The intersections of the furrows of the field with those of the head-lands, are also to be cleared out, and cuts made occasionally through the head-lands themselves.

On the lighter class of soils, ploughing in the seed may be adopted. The seed is sown broadcast, in the manner already described, after which a shallow ploughing is given to the land. A slight degree of harrowing is sufficient in this case, and, in some instances, no harrowing is given.

The dibbling of wheat has been tried in many places with success, and on rich and highly-cultivated lands there is no doubt that there are great advantages to be derived from the system. It is calculated, that more than the extra expense incurred by manual labour is saved by the quantity of seed economized. The system is well suited to the cottier and small farmer, as no expense is incurred for implements; and by digging the land preparatory to putting in the seed, the entire process of cultivation could be carried on without the expense of keeping and hiring horses, and profitable employment afforded to their own families. The great objection to this mode of putting down the grain on any considerable scale, arises from the difficulty of procuring a sufficient number of hands to perform the work. A man will make holes fast enough with the common dibble to keep three persons depositing the seed. Children may be employed at this work with advantage, as they are easily taught the method of depositing the seeds into the holes.

The quantity of seed necessarily depends on the time and mode of sowing, and the state of the land; land sown early requiring less seed than the same land when sown late, and poor land being, at all times, allowed more seed than rich; also, when sown broadcast, a larger allowance of seed is given than when either dibbled or sown in drills. The quantity, accordingly, varies from two bushels, or less, to three, and sometimes four. Winter wheat, when sown in spring, should always have a liberal allowance of seed, as the plants have not time to tiller much without unduly retarding their coming to maturity.

That soils naturally rich, or such as have been improved by cultivation and manure, will require much less seed than those in an unfertile state, is easily explained. Wheat, and all the cultivated cerealia, have the property of sending out numerous shoots from their roots during their growth, as has been already seen, and is well known to the farmer. The plants send out more of these shoots in rich and strong soils than in those of an opposite description, and, therefore, occupy respectively a greater space; they are less liable to be injured on good soils during the winter, and, generally, all come to maturity; the straw also becomes more luxuriant, and, consequently, requires a greater circulation of air to keep it in life and vigour. On light and poor soils, however, the plants tiller but partially. This deficiency of the stock on the land must therefore be supplied by producing a greater number of plants, and, accordingly, a greater quantity of seed should be sown on such soils.

The after-culture of wheat, or culture of the growing crop, is chiefly confined to harrowing, rolling, hoeing, and weeding. Harrowing is found beneficial in penetrating the crust which is formed on tenacious soils, and raises a fresh supply of mould to the roots of the plants. Rolling in spring ought never to be omitted on dry porous soils, which are frequently left in so loose a state by the winter frosts, that the roots are thrown out of the ground and perish. Hand weeding, so far as cutting down thistles and other long weeds, is never neglected by the careful farmer; but the previous culture ought to leave as little as possible of this work to be done while the crop is growing. Hoeing the crop is performed when the row culture is adopted, to pulverize the intervals between the rows, and to check the growth of weeds.

Harrowing and rolling the crop are generally performed after sowing the seeds of the clover and grasses, by which these seeds are covered at the same time that the wheat crop is improved. But these operations are found beneficial to the growing crop, and should be performed even when the smaller seeds are not to be sown. The season at which they are performed depends on the state of the wheat. The month of April is the usual time.

Fine weather should, if possible, be selected for performing these operations. The harrows are passed freely over the crop—so freely, indeed, that the field wears the appearance of being newly sown; for the plants appear buried under the soil thus freshly stirred, and an ample top-dressing is thereby given to the crop. The crust formed on the surface of the soil is thus broken, and the ground rendered more pervious to the roots of the plants, which, in a week or ten days, spread and tiller with great strength. When the plants appear growing too thickly together, an additional double turn of the harrows will remove a part of them, which will be torn up and left upon the surface; but if there be any tendency in the soil to throw out the roots of the plants, the harrowing must be very light, or dispensed with altogether, the roller being alone employed to cover the smaller seeds. These operations may be performed on every kind of soil, but, of course, with harrows proportionate to the tenacity of the land, and not heavy enough to tear up any considerable portion of the plants, unless these appeared to have been previously growing in too great quantity.

When the temperature of the season has occasioned the vegetation to be very forward, the early sown crops of wheat sometimes become too luxuriant, the vigour of the plants being exhausted by the sudden growth of a great mass of straw, and the crop becomes proportionally unproductive. From the greater height to which the straw thus rises, as well as the weakness of its stem, the crop is also more in danger of being lodged by storms, and is found to be generally more liable to mildew ; it is, therefore, in such cases, eaten down by sheep, or occasionally, though rarely, the tops are cut off with the scythe. The progress of vegetation is thus checked, but great judgment is necessary in the performance of the operation, so that it may be done without injury to the crop.

The next processes are the reaping and harvesting of the crop, which have been already described.

The amount of produce of the wheat crop varies greatly with the season, the nature of the soil, and the mode of cultivation. A good crop may be estimated at forty bushels to the acre, though the average of the country is, perhaps, somewhat less; and, in some cases, on the other hand, it is much greater. The quantity of nutritive matter is greater in autumn-sown wheat than in that which is sown in spring. One hundred parts of the former were found to contain seventy-seven parts of starch and nineteen of gluten ; and an equal quantity of the latter consisted of seventy parts of starch, and twenty-four of gluten. The weight of the straw of wheat is reckoned to be about double that of the grain.

The uses to which this grain is applied are various and well known. It is beyond every other adapted to the making of bread—a preference which it owes to the greater quantity of gluten it contains, as well as to its superior nutritive properties. It is used in various other ways for food. It is also used for making starch, which is obtained by steeping the grain, and then beating it in hempen bags. The mucilage is thus mixed with the water, and produces the acetous fermentation, and the weak acid thus formed renders the mucilage white. After settling, the precipitate is repeatedly washed, and then moulded into cakes, and dried.

The straw of wheat is applied to various purposes of rural economy and the arts. It is used for litter, and is much esteemed for that purpose. It is also used as fodder, but it is not much valued as such; however, on analysis, it is found not to be deficient in nutritive properties. It is used for making bee-hives, horse-collars, mattresses, boxes, baskets, and all kinds of what is called Dunstable work. The straw of wheat from dry chalky lands is manufactured into hats and bonnets, for which purpose the middle part of the tube, above the last joint, is taken. Leghorn plait is made from the straw of a bearded variety of wheat, which is cultivated on the poorest sandy soils in the neighbourhood of the Arno, between Leghorn and Florence, expressly for that purpose.

Wheat is subject to various diseases, some of which are peculiar to itself. Of these the principal are mildew, smut, and rust. The term *blight* is frequently applied to the first of these from its effects on the ear.

Mildew is indicated by the presence of certain minute plants of the order of *fungi*, or the mushroom tribe, which grow upon the stem and leaves, and, doubtless, feed upon and exhaust the juices of the plant. The prevalence of heavy fogs or mist, drizzling rains, and sudden changes in the temperature of the atmosphere, have been assigned as the cause of mildew; and it has been found that open airy situations are much less subject to it than low sheltered lands. It is believed that the barberry bush, and probably several other shrubs on which the fungi abound, have a powerful influence in communicating the disease to a certain distance.

When wheat is infected with smut, the farina of the grain, together with its proper integuments, and part of the husk, is converted into a black soot-like powder. If the injured ear be struck with the finger, the powder will be dispersed like a cloud of black smoke; and if a portion of the powder be wetted by a drop of water, and examined through a microscope, it will be found to consist of an indefinite number of minute and transparent globules, which seem to be composed of a clear and viscous fluid, encompassed by a thin membrane.

This disease does not affect the whole of the crop, but the smutted ears are sometimes very numerously dispersed through it. Of the infectious nature of the disease there appears to be little doubt. That it is conveyed from the seed to the future plants may be inferred from the effects of the pickling process, and although the most careful washing may not, in every case, act as a sure preventative, yet, if the seed be prepared in the way already described, the disease will rarely prevail to such an extent as to affect materially the value of the crop.

Rust is another very prevalent disease nearly allied to the mildew. It appears in the form of a brownish dust upon the stem, leaves, and seed, and, like the others, is produced by a parasitical plant.

II.—RYE.

Rye is extensively grown on the Continent, where it has been cultivated from time immemorial, although its native country has not been well ascertained. It is considered as coming nearer to wheat in its properties than any other grain. It is the bread-corn of Germany, Poland, and Russia, but in this country its cultivation is comparatively rare.

Rye belongs to the genus *Secale*, of which there is only one cultivated species—

Secale cereale—Rye.

There is also, strictly speaking, only one variety, although it is usually divided into winter and spring rye ; but these are produced merely by the different periods of sowing, and resemble each other so much, that, when sown together, they cannot be distinguished.

The soil for rye may be inferior to that chosen for wheat, and it will succeed with less culture and manure. The soils best suited to its growth are those which contain the greatest proportion of sand, and there are instances on record in which it succeeded on land containing eighty-five per cent. of this substance. Those soils, however, which contain a less proportion of sand are preferable ; for, though it will grow upon ground of the poorest description, yet the produce will be more abundant upon good land, provided it be not of a clayey nature.

Rye may be sown either in the autumn or in spring; and, as in the case of wheat, the period of ripening is affected by that of sowing.

The quantity of seed may be two bushels and a half to the acre; but when grown for straw plait, for which purpose rye is sometimes cultivated, this quantity is more than doubled. As it vegetates more slowly than wheat, it should be sown when the soil is dry, otherwise the grain is in danger of rotting in the ground before it has completely germinated.

Rye, being sown upon light and poor soils, obtains less attention in its production than wheat; it also suffers less from being sown upon the stubble of another corn crop, or even upon its own; and it is therefore not unusual to grow it successively two years upon the same land, but this is contrary to the principles of good husbandry, and cannot be recommended for imitation.

The after-culture, harvesting, and thrashing of the crop, are similar to those of wheat.

The period of flowering is more decisive of the prospect to be entertained regarding the success of rye than in the case of any other corn; and, until it be past, no opinion can be correctly formed on the subject. The ripening of the grain is earlier than that of wheat, and is denoted by the straw losing somewhat of its bright yellow colour, becoming paler, and the knots of the straw losing their green colour. The corn then sheds easily from the ear. When allowed to stand until very ripe, a shower of rain will occasion it to sprout.

The produce of rye is nearly the same as that of moderate crops of wheat, but seldom amounts to those which are very large; the quantity of straw is greater than that of any other grain. It grows to a greater height than the straw of wheat, and, though thinner in the stem, is stronger; but, being hard and wiry, it is not esteemed for fodder, and the chief use of it is for thatch. It is also in great request by brick-makers, and is extensively used in the manufacture of straw hats. For the latter purpose it is sown very thick, pulled green, and blanched by exposure to the air.

Although rye, comparatively speaking, is little cultivated in Britain, yet on the Continent it is in some parts considered as being of the utmost importance in domestic economy. Besides forming the principal bread of the inhabitants, it is used both in the brewery and distillery, and in many parts, after undergoing a species of bruising or coarse grinding, it is used alone, or mixed with barley, oats, beans, pease, or tares, which have undergone a similar operation, and formed into a kind of coarse bread for feeding domestic animals, particularly horses. Its bread contains a less proportion of nutritive matter than that of wheat, but it is found to keep longer, and forms almost the only bread eaten by the inhabitants of the high countries where the soil and climate are both unsuited for the growth of wheat. It contains a greater quantity of nutritive matter than either barley or oats, and the husk possesses an aromatic and slightly acidulous flavour, which renders it agreeable to the palate. The bran should not, therefore, be entirely separated from the flour; for if the grain be ground fine, and divested of the husk, the bread will be deprived of much of its pleasant taste.

Besides being cultivated for its grain, rye is also grown as green spring food for cattle, either alone, or, what is preferable, mixed with winter tares; in either case forming a valuable food for milch cows and young cattle, between the period when turnips and other roots are finished, and the cutting of grass and clover commences.

When rye is intended for consumption in the farmer's family, it is usual to mix a certain portion of wheat with the seed before sowing, or the mixture may be made after they are ground into flour, which is the better practice. The proportions may be one-third of rye and two-thirds of wheaten flour. This combination makes a sweeter bread than that made solely of wheat, and is preferred by those who are in the habit of using it to any other.

This plant is comparatively free from disease. It is, however, subject to a peculiar one—the ergot—also produced by a fungous plant.

III. BARLEY.

Barley, though less calculated for bread than rye, may be considered as next in value to wheat. In the northern parts of Europe it is more cultivated than any other grain, on account of its requiring so short a period in the soil—sometimes not longer than six weeks, and seldom more than seven, or seven and a half; and, in the south of Europe, two crops of barley are frequently produced in the season. Barley is a tender grain in this country, and easily injured in any of the stages of its growth, particularly at seed-time; a heavy shower of rain will then almost ruin a crop on the best prepared land, and in all the after processes greater pains and attention are required to ensure success than in the case of any other grain. The harvesting of barley is difficult, and often attended with danger; even the thrashing of it is not easily executed.

Barley belongs to the genus *Hordeum*, of which the following species may be enumerated as deserving of the attention of the cultivator, but a still greater number have been cultivated for their seeds:—

1. Hordeum vulgare—Common spring barley.
2. Hordeum distichon—Two-rowed or long-eared barley.
3. Hordeum hexastichon—Six-rowed winter barley.

The spring or early barley is distinguished by its double row of awns standing erect, and its thin husk which renders it favourable for malting. There are usually considered two varieties of this species, but they are in reality the same, the difference being occasioned by soil and culture. The seed of this species, when sown upon cold or strong land, will, the first year, ripen nearly a fortnight earlier than it would otherwise have done, when it is from a dry gravelly soil, and, therefore, the farmers in the vales purchase their seed-barley from the warm and gravelly lands; for, when produced in cold situations for two or three years, it becomes full as late in ripening as the common barley of their own production; on the other hand, the farmers on warm lands are also obliged to procure their seed-barley from the strong lands, otherwise their grain would degenerate in bulk or fulness, which by this change is prevented.

The two-rowed barley is the species in common cultivation in this country. The minor varieties of this species are numerous, and are distinguished chiefly by the quality of their grain, and by their habit of early or late ripening. Two-rowed naked barley is a variety of *Hordeum distichon*, distinguished by the corolla not being attached to the grain, but it is not determined whether this be a permanent character. It nearly resembles spelt wheat, and does not appear to be deserving of attention.

The winter barley derives this appellation from the circumstance of its acquiring a habit of late ripening when sown before winter. It is large and thick-skinned in the grain, and is much cultivated in the northern parts of Europe from its being well adapted to a cold climate. One of the kinds of winter barley, and the best known in this country, is bere or bigg. It has always six rows of grains in the ear, and the number of its grains are greater than in the two-rowed kinds, but they do not weigh so heavy in proportion to their bulk. The term winter barley can only be given to this species when sown before winter, for when sown for a number of years in spring it loses this character.

There is also a naked variety of this species known by the name of *orge céleste* which is much cultivated in various parts of Europe, and is esteemed for its fertility.

Although the number of species of the genus *Hordeum* which at present enters into cultivation is comparatively few, yet there are a great many varieties, amounting to upwards of twenty. Much confusion has arisen in the arrangement of the cultivated barleys, and in an especial degree by distinguishing them as four-rowed and six-rowed. There is, however, no barley to which the term four-rowed can be applied; being either two-rowed or six-rowed according to the number of fertile florets. Slightly examined, indeed, six-rowed barleys frequently present the appearance of four rows; but this is in appearance only, for such barleys have always the three rows on each side perfect. In poor soils, and unfavourable situations, two of the rows run much into each other; and this has, perhaps, given rise to the mistake; but the two rows, which thus run into each other in appearance, are on the opposite sides of the spike.*

The varieties of *Hordeum distichon*, notwithstanding their inferiority in quality of produce, compared with some of the six-rowed barleys, have received a more extended and careful cultivation, not only in this country but on the Continent. This arises, no doubt, from the superiority of their samples; but, were a little more attention devoted to the six-rowed sorts, by hybridizing, or selecting any superior ears which appear possessed of the fine qualities required, in a short time we might expect to see the quantity of barley grown upon a given space considerably more than at present, and the sample at the same time equally good with that now produced. There is certainly much more room for improvement in the case of six-rowed barleys than in any other of our cereal grains.

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* Elements of Practical Agriculture, p. 248.

In choosing a sort of barley for cultivation, regard must be had to the soil and climate. The hardiest may be considered the winter barley, and the earliest, and perhaps the best, is the spring barley. The long-eared is also a much-esteemed variety.

In choosing from any particular variety, the best grain for sowing is that which is free from blackness at the tail, and is of a pale lively yellow colour, intermixed with a bright whitish cast: and if the rind be a little shrivelled so much the better, as it shows that the grain has sweated in the heap, and is a sure indication that its coat is thin. The husk of thick-rinded barley, being too stiff to shrink, will be smooth and hollow, even when the flour has shrunk from it within. The necessity of a change of seed from time to time, by sowing that of the growth of a different soil, is in no instance more evident than in the culture of this grain, which otherwise becomes coarser and coarser every year. But in this, as well as in all other cases, the utmost care should be taken that the seed is full-bodied.

The best soil for barley is a rich loam finely pulverized. It will neither grow well on a sandy or a soft soil, nor on strong clays, such as are suitable for wheat. For poor, tenacious, and cold land it is wholly unfit, and except upon genial soils its culture ought not to be attempted.

The place for barley in the rotation, is after any of the green crops to which manure has been applied. It is rarely made to succeed summer fallow, wheat being in an especial degree suited to follow that process, and it being also the more valuable crop. For a like reason it seldom succeeds potatoes, as wheat may advantageously be sown at the period of the removal of the potato crop from the ground. But it succeeds turnips with greater propriety than any other crop, the turnip crop being cultivated on the lighter soils, and these are the proper soils for barley.

Barley ripens early in the autumn, and it may therefore be sown later than any of the other corn crops in the spring. The best season for sowing is the month of April or beginning of May. An increased quantity of straw is produced by late sowing, but the grain is surer the more early that the crop is sown.

The preparation of the land for barley is similar to that for wheat. After turnips or other green crop removed in the spring the land is to be ploughed once, after which the seed is to be immediately sown.

Two ploughings, however, will be necessary when barley succeeds any of the grain crops removed before winter, and in this case, the land should have been drilled up after the removal of the crop to keep it dry. As it is found of great importance with a view to speedy and equal vegetation that the ground should be fresh and moist at the time of sowing, barley should then be sown as soon as possible after the seed-furrow is given.

The modes of sowing barley are either broadcast or in rows. The broadcast system is almost universally employed in the cultivation of this plant, unless in lands much infested with annual weeds, when drilling and hand-hoeing, and, sometimes, horse-hoeing may be adopted with advantage.

The quantity of seed varies from two and a half to three bushels to the acre. The precise quantity, however, is regulated by the nature of the soil and time of sowing, as well as, in some degree, by the variety employed. Thin sowing is attended with considerable disadvantage. If the early part of the season be dry, the plants will not only be stunted in their growth, but will not send forth offsets; and if rain afterwards fall, an occurrence that must take place sometime during the summer, and often at a late period of it, the plants then begin to tiller and send forth a number of shoots. These young shoots, unless under very favourable circumstances, cannot be expected to arrive at maturity; or if their ripening be waited for, there will be a great risk of losing the early part of the crop. It is, therefore, preferable to sow a quantity of seed sufficient to ensure a full crop, without depending on its sending out offsets; for when a second growth does not take place, the crop grows and ripens equally, and the grain is uniformly good.

When barley is sown at a late period in the season, and the weather dry at the time of sowing, the seed is sometimes steeped in water for a day, to promote a more uniform and early germination. It must not, however, remain too long a period in the steep, for, in this case, germination would have proceeded so far, that there would be considerable danger of breaking off the buds; and, when placed in the soil in this advanced state, the roots would not be evolved in a proper manner, nor in sufficient quantity for the support of the plants. No process is performed with the seed analogous to the pickling of wheat, as a preventative of disease.

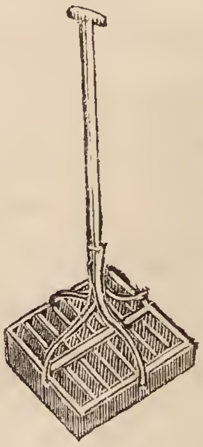
The seeds of the clovers and grasses are sown simultaneously with the barley, the succeeding crop being invariably grass. In this case the smaller seeds are sown immediately before the last turn of the harrows, and that turn covers them in. The land is to be rolled afterwards, the operation of rolling not only serving to compress the ground to the exclusion of drought, but also pulverizing the soil, and effectually covering the clover and grass seeds. In some cases it may not be convenient to sow the smaller seeds with the barley, and in this case that operation may be delayed until the crop appears above ground, and rolling alone will then sufficiently cover the seeds.

The water-furrows and drains should be then cleared out, though this is less necessary than in the case of wheat, as barley is not suited to wet soils. This closes the field operations until the ensuing harvest, unless weeds should appear, in which case, they are pulled up by the hand; for if not eradicated at once, they will obtain firm possession of the soil, as the succeeding crop of clover will prevent their being destroyed by the plough.

In the harvesting of barley, more care and attention are requisite than in the case of any of the other grain crops, even in the best seasons; and, in unfavourable seasons, it is almost impossible to save it without injury. Owing to the brittleness of the stem, after it has reached a certain period, it must be cut down; for when it is suffered to stand longer, much loss is sustained by the breaking off of the heads. On that account, it is cut at a time when the grain is soft, and the straw retains a great proportion of its natural juices, and, consequently, requires a long time in the field before either the grain is hardened or the straw sufficiently dry.

The thrashing and dressing of barley are attended with more labour than those of any other grain, owing to the tenacity with which the awns adhere to the seeds. After being thrashed in the ordinary way it is a frequent practice to put the thrashed grain a second time through the machine, accompanied by a portion of straw.

Fig. 72.



The machine, when properly adjusted for the purpose, usually detaches the awn sufficiently well, but should this not be the case, or should the barley be thrashed by the flail, then the hummelling machine is employed. This consists of a frame-work of iron plates as seen in the figure, and the barley being laid on the floor is freed from its awn by repeated strokes of the hummeller.

The produce of an acre of barley, under favourable circumstances, will amount to forty bushels. The average produce of the country is, perhaps, somewhat less, but there are repeated instances of much larger quantities being produced.

The uses of barley are various. In some parts of the country it is ground into flour or meal, and made into bread; but the bread, though sufficiently nutritious, is dark and strong tasted. It is also subjected to a species of grinding, by which the husk is rubbed off; and it is then called pot or pearl barley, a preparation largely used in domestic economy. But by far the greater portion of the barley produced in this country is used for malting, to which purpose it is admirably suited.

To understand the process of malting, it may be necessary to observe, that the cotyledons of a seed, before a young plant is produced, are changed by the heat and moisture of the earth into sugar and mucilage, as has been seen when considering the structure and functions of vegetables. Malting grain is only an artificial mode of effecting this by steeping it in water and fermenting it in heaps, and the arresting of its progress towards forming a plant by kiln-drying, in order to take advantage of the sugar in distillation for spirit, or fermentation for beer. The grain of barley contains starch and sugar; and the chemical constitution of both these ingredients is very nearly alike. In the process of malting a portion of the starch is converted into sugar, so that the total quantity of sugar, and consequently the source of spirit, is increased by the transformation.

Barley straw is used chiefly for litter and packing; it is unfit for thatch or rope-making, and of little value as fodder. It is lighter than the straw of oats or wheat. The awns of barley are found to be nutritious, and may be boiled and given to cattle mixed with other food.

The diseases of barley are few. It is sometimes attacked by the larvæ of certain flies. It is also subject to smut, but of quite a different species from that which affects wheat, and one which, it is found, cannot be prevented by pickling and liming.

IV.—OATS.

The oat is a very useful grain, and more peculiarly adapted for northern climates than either wheat, rye, or barley. It has long formed the chief bread-corn of this country, but in England and Scotland it is cultivated chiefly as horse-food. Its native country is unknown, unless the wild oat be considered as the parent species, which is highly probable. Of all the grain this is the easiest of culture, growing on any soil that admits of ploughing and harrowing.

The oat is of the genus *Avena*, of which the following species are cultivated for their seeds :—

1. Avena sativa—Common cultivated oat.
2. Avena orientalis—Tartarian oat.
3. Avena nuda—Naked oat.

Avena sativa is the species of oat in common cultivation. Each spikelet contains two and sometimes three perfect seeds, and the florets are sometimes awned, and sometimes destitute of awns, this appendage, when it is present, being considered a symptom of deterioration. Of this species there are almost innumerable varieties, produced by the different effects of climate, soil, and cultivation.

The Tartarian oat has lately attracted attention in this country, its introduction to which is comparatively recent. Its panicle is contracted and nods to one side, which distinguishes it from the common oat.

Of this species there are two varieties, the white and the black Tartarian oat. The straw of the former is very long, and it is said to be very prolific in grain, but late in ripening—a circumstance which renders it only fit for cultivation in early situations. The latter, although resembling the white in the form of its panicle, is nevertheless very different in other respects ; its straw is of a medium length ; grain more plump and less awned than the preceding. It is also one of our earliest oats, and succeeds best on high and rather inferior light soils. The culture of this variety has been for some time yearly extending.

The naked oat is distinguished by the corolla being detached from the seed, as in the case of wheat. It has been cultivated for a length of time in various parts of the country, but its cultivation has not yet become general. Having no husk, it is said, when thrashed, to resemble oatmeal, and is immediately ready for culinary purposes. The flavour is delicious, and it abounds in farinaceous matter. Its produce is large, and, from the early period at which it ripens, it is well deserving the attention of the farmer in late districts, particularly in peaty, or boggy soils, to which it is well adapted.

The greater part of the oats in cultivation in this country, then, consists of varieties of the common oat, *Avena sativa*. These, it has been said, are numerous; but the kinds deserving of attention are the Potato oat, the Hopetoun oat, the Poland oat, and a few others.

The potato oat has a large, plump, rather thick-shinned white grain, and long straw. It is very generally cultivated on all the better class of soils, but it is not so well suited to those of an inferior description as some of the other sorts. It is less productive of straw, though the grain is more plump, weighs heavier, and yields a greater return of meal. It was discovered in a field of potatoes in Cumberland, in 1788; and from the produce of the single stalk, which thus grew up by accident, has been produced the stock now in general cultivation. It has, however, in many cases, shown symptoms of decay, or degeneracy, by the husks becoming thicker, and the body less plump, and by the partial appearance of awns. But this, in certain cases, may arise from the too-long-continued cultivation of the plant on the same soil, without a change of seed.

The Hopetoun oat was raised some years ago in East Lothian, since which its cultivation has been rapidly extending. It is a few days earlier than the potato oat, and not so liable to be shed by winds: its straw is longer, and not so apt to bend or lodge; panicle larger, and more spreading; grain rather more awned, and a shade browner in colour, and easily distinguished by a small reddish mark in the centre of the front of the grain. It is generally considered to be better adapted for light, than for strong clay soils, and that it is more liable to be attacked by smut than the potato oat. But, altogether, its cultivation is still increasing, and for growing on poor late moorish or newly reclaimed lands no variety is better adapted.

The Poland oat was long valued. It ripens early and produces an abundant crop of grain; but it is somewhat deficient in straw, and is supposed to be peculiarly liable to injury from shaking. It has been cultivated in England upwards of a century, during which it has retained its characters.

The varieties of the Angus oat have been much cultivated on all the poorer classes of soils. They are hardy, of fair quality, and sufficiently productive. The early Angus is the finer variety, and ripens nearly ten days before the other, although the latter is usually considered the more productive.

The common old black oat is cultivated on the poorest description of soils, and, in the length of the straw and form of the panicle, is similar to the potato oat. The grain is large, and rather well-filled of a shining black colour, lighter towards the point. This oat was formerly much cultivated, but latterly its cultivation has become more circumscribed, owing more to its colour than to any real defect inits quality. Farmers, in some parts, have a peculiar antipathy against black or dun-coloured oats. One reason assigned for this is, that the coloured grains degenerate and become white, thus giving the sample a mixed-like appearance; but probably this mixture arises from improper management, rather than from any inherent quality in the grain. It is hardy and ripens early, and it is this property which suits it for cultivation in cold and elevated districts.

To procure new varieties, the mode of selecting the best samples only, may be adopted, as some of the most favourite sorts at present in cultivation were produced in this manner; or the same purpose may be effected by proceeding systematically by cross-impregnation, by taking advantage of the sexual organs. Degeneracy has, undoubtedly, taken place to a certain extent in some of our finest kinds; but it is presumed that this might be removed with ease, were first principles resorted to. To make a selection of the strongest ears, which carried the purest grain, is not a difficult process; and were this selection attended to by half a dozen farmers in a district, it is obvious, that the breed might be preserved pure and uncontaminated. If slovenly farmers were not then provided with good seed it would be their own fault; since if they would not take the trouble to select and breed for their own use, they might always be provided by those who were either better qualified to make a selection, or were more attentive to the interests of agriculture.

The soil for the oat may be any kind whatever, from the stiffest clays to moss, or bog, provided it be laid sufficiently dry. Oats will produce well on reclaimed bog and mountain; but as these usually grow straw luxuriantly, especially if they have been improved by paring and burning the surface, a green crop should be taken the first year, which will allow time for the active properties of the ashes to subside; and the following year oats may be considered a certain and productive crop.

The soil and climate of this country, indeed, seem peculiarly suited to the production of oats in perfection. Were the oat less suited to our soil and climate, it could not be expected that such fine crops as are generally produced could be obtained from land in such an exhausted state as that usually devoted to the production of it, and with such deficient culture as is almost invariably bestowed on that crop.

The preparation of the land for oats is less than for any other crop. It is almost always the first crop on newly broken-up lands, and, as it succeeds best on a soil not too finely pulverized, it is sown after a single ploughing. In regular rotations, oats are chiefly sown after grass; and this is precisely the period in the rotation in which the land is best suited to the habits of the plant. It is sometimes sown upon land not rich enough for wheat, that has been previously under green crop. One ploughing is generally given to the grass lands, which should be done in winter, or as soon in spring as the state of the weather and the other labours of the farm will allow. When oats succeed a green crop, the preparation of the land is the same as that for wheat.

The period for sowing oats is generally from the beginning of March to the middle of April. The month of March is considered to be the best seed-time. They are sometimes sown in February, and, occasionally, in the autumn; but the crops sown at a later period of the season have, in most cases, been greatly more productive.

The quantity of seeds is from four to six bushels to the acre. In sowing oats, the quantity must be regulated by the shape and size of the grain, as well as by the condition of the soil. Land sown with potato oats, for instance, requires less seed, in point of measure, than when any of the other sorts is used; first, because this variety tillers better than any other; and, having no awns, a greater number of grains is contained in a bushel. Some varieties, too, are more leafy than others, and require to stand further apart ; in general, however, four bushels will be necessary on medium soils, and, in poor upland soils, so much as six may be required.

Grass seeds may be sown in spring with oats, in the same manner as with wheat or barley. The young clover and grass are, however, in danger of being smothered by the oat crop, unless when it is sown very thin. If, therefore, through necessity, this system should be adopted, the oats should be sown thin on well prepared land, and the smaller seeds harrowed-in when the plants are sufficiently strong to bear the surface being stirred. When the land is in a highly-pulverized state, it may be better to sow the seeds of the clovers and grasses immediately before giving the last turn of the harrows for covering the oats.

Oats, being usually sown after grass land, are more apt to be overrun with thistles, and other large weeds, than any other crop. These are to be cut over with the weed-hook, or pulled up by the weeding clips before the crop comes into ear.

The reaping of oats is performed with the scythe or the sickle, in the manner already described. It may, with great propriety, be performed with the scythe. Oats are ready for reaping when the grain becomes hard and the straw of a yellowish colour. The crop should be cut before it is dead ripe, to prevent the shedding of the grain, and to increase the value of the straw for fodder. It rarely sustains much damage under the harvest process, except from high winds, or from shedding, when opened out after being thoroughly wetted. In harvesting oats in wet seasons, the practice of gaiting, already explained, is generally adopted.

The produce of oats is from fifty to sixty bushels to the acre. Fifty bushels are considered a good crop, but, under favourable circumstances, much larger returns have been frequently obtained.

The use of the oat in this country is well known. A large portion of the produce is ground into meal, and forms a principal part of the food of the inhabitants. Much of it is used as horse-food, the oat being the only grain given to them. From the fine powder produced by husking the corn, flummery is made, an agreeable, light, and wholesome supper dish.

The straw of the oat is esteemed for fodder, and furnishes a great part of the food of wintering cattle. It is given also to working horses in the early part of the season, when the work is not severe.

The diseases of the oat are few. Sometimes it is attacked by smut, but the more common injury sustained by oats is the attack of the wire worm, or larvæ of insects, which generally abound in newly broken-up lands. The method usually employed for guarding against the attacks of these, is by delaying the ploughing of the land, especially if long in grass, until immediately before sowing. By this means the insect is buried down, and before it can work its way to the surface, the corn will be beyond its reach.

X.—PLANTS CULTIVATED FOR THEIR ROOTS AND LEAVES.

The plants cultivated for their roots and leaves, however distinguished by the botanist, may be regarded by the agriculturist as forming a group. They are produced for similar purposes; they are cultivated by the like means; and their effects upon the soil are nearly analogous. They are, however, very various, and most of them are adapted for human food, as well as for the support of the domestic animals of the farm, while some of them are chiefly, or entirely cultivated as food for live-stock. The culture of this class of plants may be regarded as a branch of farming almost entirely of modern origin, and more particularly British than any other department of agriculture. Turnips were, indeed, cultivated by the Romans, and, in modern times, brought into notice as objects of field-culture in the last century; but they were imperfectly managed, and of very little utility in agriculture, until their culture was undertaken by the British farmer; and to the same source we are indebted for the introduction of most of the others as field-plants.

The plants cultivated for their roots and leaves, it has been said, present certain common characters in their habit of growth and mode of cultivation. Those included under this head are the potato, turnip, beet, carrot, parsnip, and several plants belonging to the cabbage tribe.

An important characteristic of these plants is, that they all belong to the class termed restorative, or ameliorating crops, in contradistinction to others which are said to be non-ameliorating, or exhausting crops; at least, according to the general method of cultivating them, they may be considered as such, being seldom allowed to mature their seeds. The turnip, for example, is not allowed to ripen its seeds, and it is, accordingly, one of the least exhausting plants in cultivation; and this, viewed in connexion with the mode of cultivating it, and the quantity and quality of the manure which its consumption affords, places it justly in the class termed ameliorating. The turnip, however, may be cultivated for its seeds; and then it becomes one of the most exhausting crops known. In like manner, the cabbage and the rape, if cultivated for their leaves, are ameliorating crops; if for their seeds, exhausting crops. The potato is, for the most part, allowed to ripen its seeds, and is, consequently, a greatly more exhausting crop than the turnip; but the mode of culture applicable to the plant, makes it be placed in the class termed ameliorating. The beet is not materially different from the turnip, so far as regards its effects upon the soil; so also are the carrot and the parsnip; but, as relates to their produce, the facility of raising them, and their uses, they stand far below the potato, the turnip, and the beet.

Each of the plants of which we are now coming to treat was, in itself, a valuable addition to the agriculture of this country. They have enabled the husbandman to supersede summer-fallows on all the lighter soils, to multiply the number of useful animals, and to increase the productiveness of his lands. One of the many means by which agriculture may be improved far beyond its present state, is by multiplying the objects of culture. Nature, it would appear, delights in variety; and we know not what objects of cultivation may yet be presented to human research. The history of the plants in question may however, well incite us to further research.*

But some of the plants of this class have been much more important than others, and, in this respect, the turnip holds the highest place. The introduction of the improved turnip culture into the agriculture of Britain, it has been observed, occasioned one of those revolutions in rural art, which are constantly occurring; and, though it came on with slow and gradual steps, it was attended by the most beneficial results. Before the introduction of this root into cultivation, it was impossible to cultivate light soils successfully, or to devise suitable rotations for cropping them with advantage. It was, likewise, a difficult task to support live-stock through the winter and spring months; and, as for feeding and preparing cattle and sheep for market at that inclement season, the practice was hardly thought of. The benefits derived from turnip husbandry are, therefore, of great magnitude. Light soils are now cultivated with profit and facility, abundance of food is prepared for man and beast, the earth is turned to the uses for which it is physically calculated; and, by being suitably cleaned by this preparatory crop, a bed is provided for the cultivated forage and herbage plants, wherein they flourish with greater vigour than after any other preparation.*

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* Quarterly Journal of Agriculture.

The plants cultivated for their roots and leaves come next in value to the cereal grasses. The gross return from them, however, far exceeds that of the latter, although it must be remembered that their cultivation is attended with much more labour and expense; but their chief value consists in their being preparatory and cleaning crops, rather than in the immediate return obtained from them.

In the cultivation of this class of plants, minute pulverization and a thorough eradication of weeds are essential to success; and the drill system is, without exception, employed. The preparation of the land, and the mode of culture for each, will be adverted to when treating of them separately; but, as the culture is so nearly the same for the different plants, it will be well to give a more detailed account of the several operations in this place, so far, at least, as these are common to the whole class of plants. This is rendered the more necessary in this country, from the great ignorance which is usually displayed in the management of drill-crops, and the indifference so generally manifested to the due eradication of weeds. The preparatory process of preparing the soil is similar to the management of the summer-fallow already described, consisting of a series of ploughings, harrowings, and rollings, the chief difference being the different season at which these operations are performed.

In the preparation of the land for drill-crops, as in the case of the summer-fallow, whatever be the nature of the soil, the first ploughing is, in all cases, to be given in autumn or before winter, so that the land may receive the influence of the winter frosts. It is of importance, that this ploughing should be deep, even should a portion of the subsoil be brought to the surface in the operation, as it will eventually improve the texture of the soil, and tend to increase its productive powers. Deep pulverization is less necessary in the case of some of the plants cultivated for their roots and leaves than in that of others; but it is useful in every instance, and in order to effect it the autumn ploughing should be deep. In giving this ploughing, the directions formerly given in the case of the summer-fallow are strictly applicable, and the like precautions are to be used for the purpose of laying the land dry during the winter.

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* Brown on Rural Affairs.

As soon as the spring seed time is over, the preparation of the land is resumed. The precise period for commencing operations is denoted by the state of the weather and the particular crop to be cultivated; for, in the case of those which are to be sown early, the preparation of the land is to be commenced at a proportionably early period. Repeated ploughings, harrowings, and rollings, are to be given until the land is sufficiently prepared. The state of the soil itself, indeed, forms the only guide for ascertaining how often these operations are to be repeated, as they must be continued until the object in giving them is fully accomplished.

In addition to the due pulverization of the soil, a main object in the preparation of the land for drill-crops is the eradication of weeds. It is, therefore, of great importance to drag to the surface and collect as large a quantity as possible of the weeds while these operations are going forward; for, this being the period of active vegetation, every particle of these weeds which is left in the ground will grow and extend itself.

These operations are frequently obstructed and greatly delayed, when it is necessary that they should be performed at an early period of the season, by severe rains, or by too much moisture in the ground. But in the case of light soils it is necessary, in very dry weather, to execute the various preparatory operations with such rapidity that the extent gone over by the plough at each half day's journey should be completed before leaving the field in the evening; and, on such occasions, the roller may be kept in motion from morning till night. Should the newly-exposed surface be damp, and little evaporation going on, the rolling must be delayed, and the harrowing proceeded with. If rain falls gently, and the soil beneath continues dry, the plough may be kept in motion, and the harrowing delayed. If the soil is wet, or the clouds portentous of much rain, ploughing should be suspended, as, under such circumstances, it seldom fails of being inimical to pulverization.

The several operations of ploughing, harrowing, rolling, and gathering weeds, are repeated until the soil is sufficiently pulverized and root-weeds disappear. Thus the object is attained piecemeal. The ploughings are to take place in different directions, as sometimes across, and sometimes diagonally, from one corner of the field to the other. Under favourable circumstances perfect pulverization of the soil is attained by these means; but, in considering the construction and mode of operation of the implements employed, it has been seen that their action is comparatively inoperative so far as concerns the eradication of weeds. To supply these defects, therefore, the grubber is to be introduced; and by the combined action of the plough, the harrow, the grubber, and the roller, the desired tilth and cleanness is effectually produced.

Pulverization has been already seen to be a mean of increasing the productive powers of the soil. It aids the retention of contained moisture, and absorption of that which nature from time to time supplies, which is so essential to the growth of the plants under consideration. An imperfectly pulverized soil exposes additional surface to the action of the sun and wind, which facilitates the escape of moisture by evaporation. A cloddy surface, indeed, directly aggravates the evils of drought, and diminishes the beneficial agency of moisture, and is so unfriendly to the growth of the crops treated of, in almost every stage of their existence, that copious and frequent rains can alone counteract the want of pulverization.

Soil is known to be consolidated by moisture, pressure, and drought, and pulverized by the expansive properties of water and agricultural operations. Copious rains seldom fail to consolidate soil not of a siliceous or peaty nature; and if immediately followed by pressure from animals and implements, or drought, their pulverization, however perfect it may have been, is destroyed. The injurious effects to pulverization, arising from the pressure of the soil in a wet state, are well known. Particles of soil, when saturated with moisture, are distended and emollient, and if acted on by pressure, water will be expelled; the particles lose their porosity, and become consolidated. When soil in this state is acted on by drought, it becomes hard, resembling the nature of brick, and its complete pulverization can only be restored afterwards by the expansive properties of water, aided by judicious tillage.

When the ground is sufficiently prepared, and the proper season for sowing the crop arrives, the land is to be formed into drills. This may be done with either the single or double mould-board plough, the latter performing the work with more expedition, and the former in general executing it with greater neatness, and in a more perfect manner. The double mould-board plough forms the drills at one stroke, while the other goes and returns by the same track; but the common plough may also be used in forming the drills at a single turn, and thus supersede the use of that with the double mould-board.

It is found to be a good arrangement, in the cultivation of drill crops, to allow the land to remain as short a time as possible exposed to the influence of the atmosphere, from the formation of the drills until the manure and seed are deposited in them, and covered up; and this arrangement is easily secured by the use of the common plough. In this case such a number of drills is to be formed before the operation of manuring commences as will be sufficient to allow the work to be carried on without interruption. Ten or twelve drills will usually be sufficient for the purpose. A drill is then formed at one turn, by the plough passing up contiguous to the last-formed preparatory drill, with the mould-board inclining to the undrilled portion of the field. When the plough reaches the extremity of the field, it is to be turned to the left hand, and passed down the centre of the first-formed preparatory drill, by reversing which a new one is formed, covering the manure which was deposited in the interim. In this manner the plough forms a drill for receiving manure or seed in its centre in passing in one direction, and another covering the manure or seed in passing in the contrary direction, until the field is completed. The depositing of manure and seed in the drills is encircled by the plough, which may either form drills with the mould-board inclining from or to the undrilled portion of the field; but the latter plan is, in general, to be preferred.

There must be a limit to the width of drill, which can be formed by the common plough at a single turn. Something will depend on the plough, its guide, and the soil; but, under ordinary circumstances, no difficulty will be experienced in the formation of drills thirty inches apart. It requires a good ploughman to form drills with one turn of the common plough, and, although they do not, in the first instance, appear so finished as when formed with a double turn, the most experienced eye cannot make a distinction after the roller or harrow has passed over them.

The manure is conveyed to the field in carts, and deposited in heaps in every third drill. It is of importance, with a view of securing the equal distribution of the manure, that the loads should be of an equal size; and every load is divided into three or four portions with the dung-drag by the carter, who is also to apportion correctly the distance between the heap. A band of spreaders then follows, consisting of a man and two boys or girls. The man takes the centre drill, and in addition to spreading the due portion of manure along it, he is to divide the heaps for the others, so as to secure the manure being equally distributed over the ground.

Thus far the preparation of the soil is the same for each of the plants belonging to the class now under consideration. In certain cases, the manure is to be covered by reversing the drills without planting or sowing the seeds; in others, the seeds are deposited before covering the manure. Each of these cases shall be successively described when treating of the particular plant to which they are applicable.*

I.—THE POTATO.

The Potato is a native of South America, from which it was introduced into this country by Raleigh, and was cultivated for a length of time in gardens as an ornamental rather than a useful plant. Its

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* The nutritive products in 1000 parts of the plants treated of in this section, will be seen by the following table:

Name.	Soluble or nutritive Matter.	Mucilage or Starch.	Saccharine Matter.	Gluten or Albumen.
Potato . .	240	160	17	32
Swedish Turnip	65	10	50	—
Common Turnip	45	7	34	2
Beet . . .	142	14	120	20
Carrot . .	98	3	95	—
Parsnip . .	99	9	90	—
Cabbage . .	75	41	25	8

culture, however, soon spread when its properties became known, and it forms now a great part of the food of the inhabitants, not only of this country, but of Europe. The introduction of the potato into this country has been assigned by different political economists as the chief cause of the poverty and wretchedness with which it abounds. Be this as it may, its importance as an agricultural plant is now well known and fully acknowledged; and it cannot be questioned for a moment, that it has greatly lessened the hazards of famine, and added to the comforts of the labouring classes in the countries to which it has been introduced.

There is, perhaps, no vegetable product, not even excepting the cerealia, or the most useful of the palm tribe, which has proved of such essential importance, or which is likely still to have such an influence on the population of the temperate regions as this admirable root. It could scarcely have been believed that, in little more than two centuries, a small and almost neglected tuber, transported from the newly discovered regions of Mexico, where it occupied but a very insignificant space, and was but sparingly, if at all used as human food, should have been multiplied so as to form the principal subsistence of millions of human beings for successive generations.

The potato belongs to the genus *Solanum*, several species of which are cultivated for their uses in domestic economy and the arts, while others are known as deadly poisons. Of all the species, the most important is—

Solanum tuberosum—The tuberous-rooted nightshade, or potato.

The varieties of this species may be said to be almost innumerable. They differ in their leaves and bulk of haulm; in the colour of the skin of the tubers; in the colour of the interior compared with that of the skin; in the time of ripening; in being farinaceous, glutinous, or watery; in tasting agreeably or disagreeably; in the length of the stolones to which the tubers are attached, in blossoming, or not blossoming; and, finally, as to the soil which they prefer.

The potato is reproduced from planting the tubers, and occasionally by sowing the seed which is produced on the stem. Climate, soil, and mode of culture, to a certain extent, produce changes in the nature and habit of the plant, but the innumerable varieties in cultivation cannot be attributed to this cause, being the result of raising the potato occasionally from seed, as other plants.

The great number of varieties produced, even from a single apple, is astonishing. In an experiment recorded by Doctor Anderson in the Communications to the Board of Agriculture, he says that the diversity was so great as to be little short of infinite. The potatoes were diversified prodigiously in regard to *colour*, being of various hues; to *shape*, long, round, and knobbed in various proportions; to *size*, some of them being no larger than pease, while others exceeded the size of the largest pullet's egg; to *earliness*, some of them, having completed their growth, would be entirely ripe before the month of August, while others were only coming into blossom in the month of October; to *prolificacy*, some yielding nearly a hundred, and others only three or four; to *mode of growth*, some running out to a great distance, others growing quite close to the stem, some growing deep down, while others rose to the surface; to *quality*, some being tough and watery, others dry and meally, some very pleasing to the taste, others not eatable; and respecting *stems*, some producing a single stalk like a rod, others an immense profusion of stems, some very luxuriant, others extremely dwarfish.

New varieties being therefore, so easily procured, it is not to be wondered that there are so many in cultivation. With respect to choice of sorts, no directions can be given, which would be of any service to the cultivator, as the names of the varieties are so arbitrary, and the same variety is not unfrequently known by different names in different districts. In selecting a sort for cultivation, attention should rather be paid to its properties than to any local name. The varieties in cultivation at the present day are, no doubt, greatly superior to that from which they all originated, and it may be believed, that the plant is yet susceptible of as great a degree of improvement as has been already effected, were attention devoted to raising new sorts from seed.

When the plants are propagated from seeds, they require to be planted for several successive years before they attain their full size; and hence it is, that this method of reproduction is so seldom adopted. When they are raised at once from the tubers, they yield their full produce in one season, and this is, accordingly, the plan usually followed.

When potatoes are raised from seed, some of the largest and best formed berries are to be selected in the autumn, and the seeds taken from them, which, after being separated from the pulp, are to be dried, and stored in a dry place until the following spring. They are then to be sown in rows in a bed, and when the young plants are two or three inches high, they are to be thinned to the distance of four or five inches. The produce is taken up in the autumn, when they will have attained the size of small plums. The fairest and best are selected from these, for planting again, and the treatment of the plants during this second season differs little from that of the general crop, the chief particulars to be attended to being the pulverization of the soil and the destruction of weeds during their growth, and observing to allow them sufficient room to come to maturity. They will now be found to ripen at different periods, from the diversity of habits of the various kinds, and as each sort becomes ripe, which will be denoted by the decay of the stems, it is to be taken up in succession, preserving only a limited number of such as have most desirable qualities, and keeping each separate, otherwise an unmixed stock cannot be procured. At this period they will have attained a considerable size, although an opinion cannot yet be confidently pronounced upon the merits of the different sorts; they are, therefore, to be planted and treated in a similar manner for another season, when the sorts deserving of attention may be easily distinguished and preserved, the others being rejected. It is better, however, to preserve a sufficient number of sorts, keeping the produce of each separate, as some of their permanent characters might not yet be fully developed.

But some of the winter sorts of potatoes do not blossom, and consequently, do not, under ordinary management, produce seeds. To procure blossoms and seeds from them, it is necessary, from time to time, during the early part of the summer, to remove the earth from the roots of the plants, and take away the potatoes as they begin to form. By thus preventing the strength of the plant from being employed in forming tubers at the root, it will be directed to the stem and parts of fructification, and blossoms and seeds will, accordingly, be produced. But the formation of underground tubers being prevented, cauline bulbs may be produced. These will be seen seated at the axils of the leaves, and are of a greenish colour. They must also be removed as they appear, otherwise the nutritive juices of the plant being diverted from the ordinary organs of fructification might fail to effect the object, and the blossoms turn out abortive.*

It is thus that new varieties of the potato are procured; and, although the process is tedious, and attended with some trouble, there is every inducement to make a trial. Nor is it from seed alone that improvements may be made in this respect. Every one who has bestowed attention to the culture of the potato must have observed, that stems greatly more productive than others are to be met with in every field. Although this may sometimes happen from a circumstance in no way depending on *kind*, yet, in general, there is room to suspect that it way be owing to some peculiar property not possessed by others. The best of these individual stems, therefore, ought to be picked up with care, and the produce of each stem kept by itself, until their qualities be ascertained, when the best are to be carefully selected for reproduction. It is almost incredible the great improvement that might be effected by paying attention to these circumstances, and the great additional quantity of produce which might thus be obtained.

Every potato contains a number of buds or germens, commonly called eyes, from each of which a stem will arise. This gave rise to the common practice of dividing the tuber into a number of sets, each having, of course, one or more eyes, as being a more economical plan than to plant the potato entire.

Many approve of planting the potato entire, and this mode has certainly been gaining ground in this country of late. A greater security is thus provided against the occurrence of failure in the crop, but a much larger quantity of seed is required. The smaller and middle-sized potatoes are preferred for planting whole; and, perhaps, the better plan is to use an equal portion of whole and cut potatoes, as in the event of the cut potatoes not succeeding, there will be a sufficient quantity of the others for a crop, and a considerable saving of seed will be effected.

When potatoes are cut for planting, the sets should be of a sufficient size to nourish the stems which proceed from them during the first stages of their growth; for it is evident to any one possessed of the smallest degree of practical knowledge of the nature of vegetables, that the strength of the stem at the outset depends in direct proportion upon the vigour and power of the set. The set, therefore, should be large, rarely smaller than a fourth part of the potato; and, if the potato is of small size, one-half may be profitably used; at all events, rather err in giving too large than too small seed; because, by the first error no great loss can be sustained, but by the other, a feeble and late crop may be the consequence.*

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* This expedient, with numerous others equally interesting to the scientific cultivator, was the invention of the late Mr. Knight.

It is a generally received opinion, that potatoes not fully ripened at the period of taking up the crop, are better calculated for seed; and it has also been recommended, to cut the potatoes for this purpose a considerable time before planting; but the propriety of both of these practices has been much questioned, and it cannot be regarded as settled at present.

When attention is directed to the culture of the potato, and it is wished to have an early crop, it has been found that the position of the set or tuber, as the case may be, is not a matter of indifference. The eye from which the leading shoot will proceed is easily ascertained, and when the set is so placed that this shoot shall proceed from the upper part of it, an early and vigorous stem will be produced; but, if the position be reversed, many weaker and later shoots will spring up; and not only the earliness, but the quality of the produce in size may be affected.

Greater certainty in the produce of the crop is ensured by using the tubers entire; but besides a larger quantity of seed being required by this plan, a greater amount of produce is found to be obtained by using sets. These should have two or three well defined eyes, and of considerable size. The sets taken from the upper or watery end of the tuber are preferred to those taken from the other end, as having better eyes, and sending forth their shoots much sooner than the others. In the dry end of the potato many eyes are to be seen not well defined, and having no appearance of a vigorous shoot, and these are in all cases to be rejected.

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* It is well known that in spring potatoes shoot out, and in stirring, moving, or cutting slices, many of these shoots fall off, and are commonly thrown away. They may, however, be preserved and planted with success, instead of cuttings; by which means there is a saving of seed to a certain amount. Sprouts are fit for planting at any time after they acquire roots sufficient to support themselves, independent of the mother potatoes, which they generally do when about three inches long. They may be planted successfully in all the various methods by which potatoes are usually planted. They answer best when laid horizontally, covering them in every instance as potato sets are treated.

The soil in which the potato succeeds best is a light loam, neither too dry nor too moist, but, if rich, it is so much the better. It may, however, be grown well on many other sorts of land, especially those of the mossy, moory, and similar kinds, where they are free from stagnant moisture, and have had their parts well broken down by culture, and the application of a sufficient quantity of manure. Peaty soils often produce large crops; and it is one source of great value in this plant, especially in this country, that it can be so successfully cultivated on newly-reclaimed land. On wet clays the return is inferior in productiveness and quality; and when repeated too frequently on the same soil, the potato becomes deficient in flavour.

Potatoes should, except in peculiar cases, be cultivated by the plough. The cases in which spade-culture may be advantageously adopted are in newly-reclaimed lands, not yet entirely cleared of obstructions, and in steep banks inaccessible to the plough. Spade-culture may also be adopted by the cottier and small holder; but this mode of cultivation is so well understood in this country that any account of it would be unnecessary.

The potato belongs to the class of restorative and cleaning crops; and it should, therefore, succeed a corn crop, and be succeeded by another. Sometimes potatoes are planted upon land newly broken up from grass, in which case, the ridge, or lazy-bed system is employed, and excellent crops are produced. But this is a deviation from the rules of practice already laid down, and cannot be recommended, except on rough land not previously under tillage.

In the preparation of the land for potatoes, it is of importance to free it, as completely as possible, from root-weeds, which cannot be so well extirpated afterwards, as in the culture of the turnip, and some other drill crops, both because the horse-hoe must be excluded altogether at a time when vegetation is still vigorous, and that, at no period of their growth, is it safe to work so near the plants, especially after they have made some progress. It is the earlier time of planting and of finishing the after-culture of the potato that renders it a very indifferent substitute for fallow, and, in this respect, in no degree comparable to the turnip.

A liberal supply of manure is necessary to produce a good crop of potatoes, unless the land is unusually fertile. That employed is chiefly farmyard dung. It is not necessary that it should be so completely fermented as if intended for turnips; but such a degree of fermentation is obviously requisite as will ensure the complete decomposition of the manure after being applied to the land.

As soon as the manure is spread along the intervals of the drills, the potatoes are to be planted. The sets are placed ten inches asunder in the rows, and if a mixture of whole and cut sets be employed, they are planted by different persons, or by the same person going a second time along the drill, the sets being first placed at double the required distance. It is of importance that the sets should be placed in a right line along the centre of the hollow space between the drills, as those placed out of this line are in danger of being injured in the after-culture of the crop.

The sets are usually placed upon the manure, but some recommend placing them under it, as being the better practice. In the ascent of the shoot it naturally protrudes through the dung when placed over the set, and the numerous fibres or stolones, extending from it, must thus come much more readily in contact with the manure. The superiority of this plan has, in many instances, been quite apparent, but it is attended with some additional trouble.

The manure being spread and the potatoes planted, the drills are reversed for the purpose of covering the manure and seed. The distance between the drills for potatoes may be thirty inches, to admit of sufficient culture being bestowed on the crop while growing. When the soil is light, and the weather dry at the time of planting, the drills may be immediately rolled with a light roller to consolidate the earth so as to prevent undue evaporation, which would have the effect of retarding the growth of the crop.

The usual period of planting is during the month of April and the first week in May. Some of the early sorts may be planted in March, but it is usually the end of April or beginning of May before the land can be prepared for the general crop. There are many instances of good crops being obtained after planting in the end of May or beginning of June, but such late planting cannot be recommended. The produce from early planting is always superior in regard to quality, although the quantity may be less.

The quantity of seed depends upon the size to which the potatoes are cut, or whether they are planted whole. In general, when the sets are of sufficient size, from twenty-four to thirty bushels will be required to the acre.

The after-culture of potatoes consists in harrowing, hoeing, weeding, and earthing up the crop.

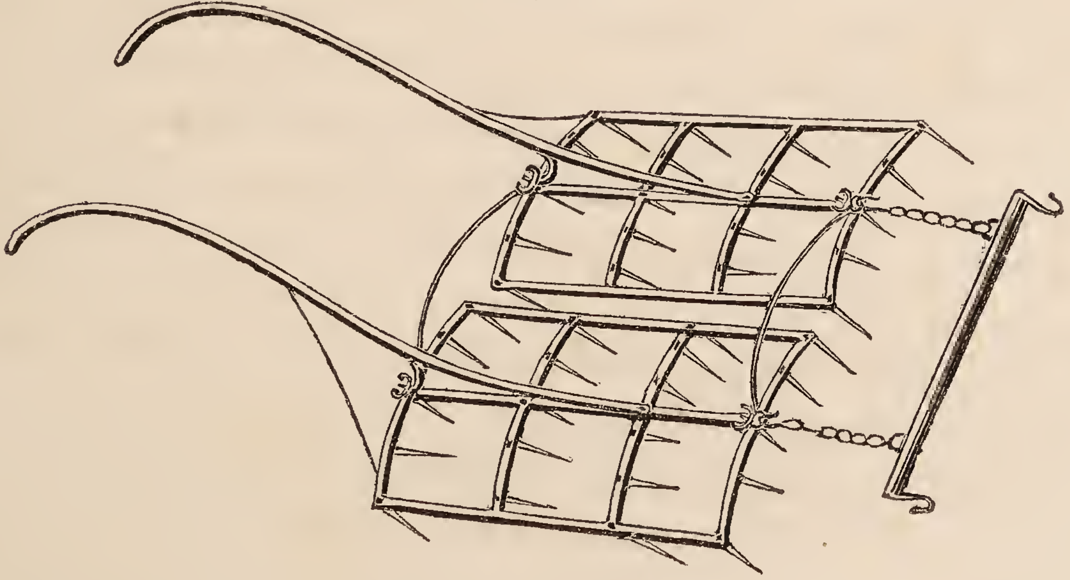
In a fortnight or more after planting, the whole field is to be harrowed across with the light harrows usually employed for covering grass seeds. The effect of this tillage will be partially to level the ground, and destroy any weeds that may have begun to vegetate. The depth of covering over the potatoes will be materially reduced by this operation, and the soil well pulverized, both of which will contribute to accelerate the growth of the plants. By levelling the drills it is also considered that the stems come better up in a direct line, the deep covering of earth immediately over them having a tendency to make them come through the sides of the drills. Independent of this, however, the harrowing is eminently useful in the destruction of weeds, and should never be omitted.

When the plants have got above the ground the horse-hoe is to pass along the intervals between the rows, the lateral coulters passing as near as possible to the plants without injuring them; or the common plough may be employed, passing twice along each interval, and taking the earth from each row. The hand-hoers follow to hoe the rows of plants carefully, cutting down all weeds that may have escaped the action of the horse-hoe or plough. The land may then remain in this state for a week or ten days, after which the horse-hoe with lateral coulters is again to pass along the intervals, and the weeding is repeated. The space between the rows is thus thoroughly pulverized, and the earth between the plants is also loosened at the same time the weeds are cut down. When these operations are performed at an advanced period of the growth of the crop, it is of importance to contract the distance between the coulters of the horse-hoe, as working among the fibres or stolones of the plants is found to impede their growth in a great degree.

The last operation in the after-culture of potatoes is raising the earth to the stems of the plants. The drills are now restored to their original shape, in which state they remain until the crop is ripe.

The operations described are generally found sufficient to clean the ground in an effectual manner, but occasionally deviations may be advantageously adopted. It sometimes occurs, for instance, that the land cannot be sufficiently prepared without delaying the planting of the crop to an improper season; and, in this case, it is better that the planting process should not be delayed, even should the land be rough. When the ground has been improperly prepared it will turn up into large lumps in drilling, and it will be necessary to break them by persons going through the drills with three-pronged forks, in order that the seed may be sufficiently covered. Harrowing down the drills in the ordinary way would evidently be improper here, as the action of the harrows would tear up the lumps, which were but partially reduced by the forks, and uncover the seed. But, to remedy this inconvenience, a harrow of peculiar construction is employed.

Fig. 73.



As in the case of the common harrow, it consists of two parts fastened by a moveable joint in the centre. Each of these parts is of a sufficient size to cover one drill, and is constructed with such a degree of concavity in the lower side, that the sides of the harrow reach to the bottom of the intervals on each side of the drill. The harrow is drawn by one horse, and a handle is attached to each side, which is held in the same manner as the handles of the plough.

From the construction of this implement, it is at once apparent that its action must be in a longitudinal direction. The teeth are not so long as to penetrate any considerable depth into the ground, and, affording but little resistance, it rarely occurs that a lump of earth is turned out of its place. When the action of the harrow becomes obstructed by weeds or lumps of earth, the person behind, by means of the handles, lifts it over the obstruction; and, by giving such a number of turns as the state of the land seems to require, it will be, at length, thoroughly pulverized, without interfering with the growth of the crop. It is sometimes found necessary to collect the weeds after this harrowing, as a great quantity is often separated from the earth forming the drills. The after-management is the same as that already described.

When the preparatory operations have been performed in a proper manner, the use of this instrument will not be necessary. The process of preparing land at an early part of the season is, however, a troublesome one, and, in every case where this has not been properly done, it will be found efficacious. The after-culture may also, in some other respects, differ from that described; but such variations will readily occur to any intelligent cultivator, who will have little difficulty in suiting the mode of culture to his own particular case.

Plucking off the blossoms of the plants, and thus preventing them from ripening their seeds, has been recommended, with a view of increasing the produce of the crop. We have formerly seen that plants are exhausters of the soil according as they are allowed to bring their seeds to maturity or not; and when it is considered that the seed is the essential part of every plant, and that to which the ultimate efforts of nature are always directed, it will be allowed that an important part of the nourishment of every vegetable must be devoted to this purpose. In the case of the potato every one knows that the weight of the apples grown by a single plant is very considerable; and it has also been seen that apples may be produced in those varieties which usually do not produce any, by the removal of the tubers. From this it would appear that the practice of plucking off the blossoms is founded on a just knowledge of the physiology of vegetables, and this is undoubtedly the case. When the blossoms are taken off, the juices of the plant, which would otherwise be consumed in maturing the seed, are turned to the production of tubers, and must, of course, increase their growth. From the trials that have, as yet, been made, the increase in produce has, in general, been inconsiderable; although Knight considered that an additional ton to the acre might be thus produced. The subject is, however, deserving of more consideration than has yet been bestowed on it.

The period of ripening of the potato is indicated by the decay of the stems, and by the facility with which the skin, or outside covering of the tubers, is removed. It is highly improper to take up the crop before the tubers have attained maturity, as they are otherwise liable to be injured in the store; but it is not, by any means, necessary to delay the operation until the stems are altogether decayed. The usual period is in the beginning of the month of November.

The operation of taking up the crop may, upon a small scale, be performed with a three-pronged fork, or graip, as it is more usually termed, constructed for the purpose; but, on the large scale, the work is more expeditiously performed by the plough.

When the crop is taken up by the graip, the common plough, deprived of its coulter, passes along the intervals of the drills, and pares a slice of earth from each side, which is thrown to the centre. Persons with graips then follow, and dig up the portion of the drill which remained untouched, each person taking two drills which he turns over in alternate portions, and observing, at the same time, to toss over the loosened earth left in the intervals by the plough, so that none of the tubers remain covered up in the ground. The potatoes are gathered up into baskets by boys or girls as they are turned out, and emptied into carts, in which they are conveyed to the place of storing the crop.

When the crop is taken up by the plough, that with either the single or double mould-board may be employed. In the former case, the coulter is taken from the plough to prevent it from cutting the potatoes; and it then passes along the centre of each drill with a deep furrow, reversing one half of it. It is to be followed by a sufficient number of persons to collect the potatoes into baskets. It is then to return by the same drill, reversing the other half of it, so that the whole tubers of the drill are turned up. Time is saved in this operation by the plough, after laying open the half of one drill, passing to another drill, when there is a like number of persons to follow it, and so on to another. It then returns to the first drill and reverses the other half of it, and so on, in succession, with the other drills. Often, however, the plough reverses an entire drill at one time. After the plough has reversed the different drills, the harrows should follow, so as to bring to the surface any tubers that may have escaped. In this manner the gathering of the potato crop, which, in many cas is regarded as a work of time and labour, is performed with economy and despatch.*

Potatoes are sometimes taken into a house appropriated for the purpose, as the crop is taken up, and there stored for use. This is an effectual and convenient method of disposing of the crop, and may be practised where potatoes are cultivated, only on a small scale. The potato, however, being so generally cultivated, and frequently in large quantities, storing the crop in this manner can seldom be attempted, as the quantity cultivated on the farm would fill the greater part of the buildings on it.

The more frequent practice, therefore, of securing the crop, is to form the tubers into oblong heaps, technically termed pits, or pies. In forming these pits, a trench, one foot deep and six feet wide, is made, and the loose earth shovelled out and laid on each side. The potatoes are emptied into this from the carts, and piled up to a considerable height in the form of a house roof. The carts may be backed into this trench, and the load emptied up against the others, which will save much labour in forming the heap; but, in this case, it is necessary to place a thick piece of wood across it, which must be of sufficient length to reach from one side to the other, in order to prevent the cart-wheels from injuring the potatoes. When they are carefully heaped up, the whole is covered with straw, and afterwards with earth taken from the sides of the heap, to such a depth as to exclude frost.

The produce of the potato is exceedingly various, and is, in general, much greater in this country than in either England or Scotland, but more especially the former. Under a good system of culture, and after a liberal application of manure, twelve tons per acre may be expected, although the average produce of the country is considerably below that amount. From fourteen to sixteen tons per acre have, however, been frequently obtained.

The most important application of the potato is as human food, and, in this country, it forms the chief article of food of the lower orders of the population, but it is so greatly relished by every palate, as to occupy a place on the tables of all classes of society. It is also extensively used as food for cattle; and a large quantity of ardent spirit is obtained from it by distillation, for which purpose, it is extensively employed in the distilleries of France and the Netherlands, although its employment for that purpose in this country is comparatively rare.

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* Elements of Practical Agriculture.

The potato contains a large proportion of fecula, or starch, amouning to one-fifth of its entire weight. The mode of obtaining this substance is well understood throughout this country, potato starch being frequently substituted for that procured from wheat, to which it is little, if at all, inferior. It is perfectly nutritious, and is largely used in the culinary and confectionary arts. Being deficient in gluten, when used alone, it is incapable of undergoing the panary fermentation, and is, therefore, not so well calculated for making bread as the flour of wheat; but it may be mixed with the latter in a given quantity so as to produce good bread. Potato starch is frequently substituted for the arrow-root of the shops as food for invalids, and it may be procured at about one-tenth of the price of that article.

Potato flour is made into bread in a very simple manner. Its adhesive tendency does not admit of baking or kneading unmixed with meal or wheaten flour; but it may be made into cakes in the following manner:—A small wooden frame, nearly square, is laid on a flat pan, like a frying-pan; this frame is grooved, and so constructed, that, by means of a presser, or lid, introduced into the groove, the cake is at once fashioned according to the dimensions of the mould. The frame containing the farina may be almost immediately withdrawn after the mould is formed upon the pan; because, from the consistency imparted to the incipient cake by the heat, it will speedily admit of being safely handled. It must not, however, be fired too hastily, otherwise it is apt to become unpleasantly hard, and unfit for mastication. This precautionary measure being observed, it will be found that, when thoroughly ready, the bread of potato flour, even unaided by any foreign ingredient, will be very palatable. It might thus, from time to time, be soaked for puddings, like the tapioca; or it might be used like the cassada-cake, which, in appearance and quality, it so much resembles.

Wine of a good quality may be made from frosted potatoes, if not so much injured by the frost as to become soft and watery. The potatoes are to be crushed or bruised with a mallet, or put into a cider press. To a bushel of the potatoes, ten gallons of water is to be added, prepared by boiling, and mixed with half a pound of hops, and half a pound of common white ginger. This water, after having boiled half an hour, is to be poured upon the bruised potatoes, into a tub, or vessel suited to the quantity to be made. After standing in this mixed state for three days, yeast must be added to ferment the liquor. When the fermentation has subsided, the liquor is drawn off, as fine as possible, into a cask, adding half a pound of raw sugar for every gallon. After it has remained in the cask for three months, it is ready for use.

For the production of ardent spirits, potatoes which have been injured by frost are preferred to those that are fresh, as they not only produce a much greater quantity of spirit, but that also of a much finer qualtity. In every case, a proportion of malt-wash is required to promote fermentation. About one-fourth part of malt-worts, or wash, ought to be fermented at least six hours before the potato-wash is added to it, otherwise the latter, having an aptitude to ferment, will be ready for the still before the former; and the effect will be to generate an acid which renders the spirit coarse, and, when diluted with water, of a milky or bluish colour.*

In the application of potatoes as food for live-stock, they are often joined with hay, straw, chaff, and similar matters, and have been found useful in many cases, especially in the later winter months, as food for horses and cattle. They may be given either in their raw state or boiled; but in the latter case they are greatly more nutritious. Boiled or steam potatoes, mixed with cut straw or hay, may be given to horses, even when on the hardest work, and they form a species of food both nutritious and economical.

The diseases of the potato are not numerous. The chief are the curl, the worm, and the scab.

The curl is the most formidable disease to which this plant is subject, but it is now, happily, much less prevalent than formerly. It is known by the curling of the leaves, and their consequent diminutive size. The inquiries of the scientific cultivator had long been directed to the finding out either of the cause or cure for the disease, but it is more to accident that we are indebted for what is known respecting it, than to any minute inquiries on the subject. By observation the farmer ascertained that, by using seed from newly reclaimed or mountain land, a case of curl rarely occurred in his crop, and hence the origin of the practice now so general of changing the seed repeatedly, and obtaining, if possible, that produced in the situations mentioned. Using unripe tubers is also said to be a preventative of the disease, and especially such as have not been allowed to produce seeds.

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* Edinburgh Farmer's Magazine.

The worms sometime attack the tubers in the ground, and greatly injure them in certain situations, but they may be destroyed by spreading some salt on the ground before planting. The scab is not a disease of frequent occurrence, and the only remedy consists in giving good tillage to the land.

Independently, however, of the curl, and every known species of disease, a very extraordinary failure has taken place since 1832, in the crops of potatoes, extending, in some cases, over entire districts, and, in others, partially confined to portions of particular fields. Various essays have been recently written with a view to ascertain the cause, and facts and inferences are therein brought forward which may, perhaps, lead to its discovery. Some of them, indeed, appear to carry such a weight of evidence with them, that they might almost be assumed to be conclusive, did they not vary so much from each other, and did they not all leave, in some degree, unaccounted for the singular circumstance, of the same land, tilled and manured in the same manner, planted with the same sort of tubers, and, at the same time, failing in one part, and being productive in another, as well as the disease being only of recent occurrence. It has been extremely capricious in its attacks; and we are still in the dark regarding the failures which have occurred, it being highly probable that none of the various theories which have been assigned may touch the true cause. But the remedy being, in the mean time, undiscovered, a preventative should be tried. Raising new varieties from seed is, therefore, deserving of the attention of the farmer on this account alone, as it has been recommended by the majority of the essayists on the subject. Although the cause of the disease remains, and is likely still to remain, a secret, much good has resulted from the attention of scientific and practical men being turned to the subject; and it is certain, that much more attention is paid to the careful cultivation of the potato since the failures alluded to took place than was formerly devoted to it.

II.—THE TURNIP.

The introduction of the turnip as an agricultural plant has been seen to be among the most important improvements which have been effected in British agriculture. It is an indigenous plant, but, in its wild state, it is difficult to distinguish it from wild mustard. The improved turnip, as now cultivated in our fields and gardens, compared with the wild species, shows, in a striking degree, the effects of culture in changing the habits and appearance of vegetables.

The turnip belongs to the genus *Brassica*, a family of plants which is of great utility, whether we consider the adaptation of the different species to the purpose of supplying man, as well as the inferior animals, with wholesome and nutritious food; or the large return which is obtained by their cultivation from a given extent of land. As commonly cultivated, they are rather restorative than exhausting. They are biennial plants, sending up a large quantity of succulent leaves the first year, and a high and branching stem, bearing a profusion of seed, in the second. Were their culture extended to the second year, they would become eminent exhausters, but, in the practice of the farm, this is extremely rare.

Of the genus Brassica there are two species to which the different varieties of the turnip in cultivation belong:

1. Brassica rapa—Common turnip.
2. Brassica campestris—Swedish turnip.

The varieties in cultivation are numerous, produced chiefly by impregnation during the time the plant is in flower. Those of the common turnip are a great deal more numerous than those of the Swedish, compared with which, they are also, in general, of much finer symmetry, as well as of a larger size, differences which may be partly accounted for from the circumstunce, of the common turnip having been longer in, and received a more extended cultivation. An important division among the varieties of the common turnip, is that of whites and yellows. Of the whites, the most generally esteemed and cultivated is the globe, and of the yellow, the yellow Aberdeen.

The different kinds of the globe turnip have, as the name implies, globular roots, with a small neck and tap-root; the skin perfectly smooth, being of a bright white below the surface of the ground, and green above it. They grow to a large size, and come early into use; but, being tender, they should be consumed at an early period of the season, while the leaves are green, as they are easily injured by the frost.

Although the different kinds of globes present certain common characters, there is much diversity in those to which the name is usually applied, arising from the degree of care and attention bestowed by cultivators, and more especially by seed-growers, in the selection of their seed-roots; and their shape is often not a little affected by the kind and state of the soil in which they were grown. Thus, globes of any kind, when grown on a very superior rich soil, may be said to be forced beyond their natural size, and, thereby, acquire somewhat of a monstrous and overgrown appearance, losing, in a great measure, their natural symmetry of shape.

The yellow turnips appear to be intermediate varieties between the globe and the Swedish turnips. An esteemed variety of yellow turnips is the yellow Aberdeen. It is of a hardier nature than the globe, and is of considerably slower growth; it is, therefore, sown earlier, and remains a much longer time in the ground. It produces large crops; and, although it is inferior to the globe in this respect, it is much more nutritious, a given quantity supporting a greater number of live-stock. Of this sort, there are many minor varieties, chiefly distinguished by the colour of the portion of the root above ground, and of the leaves; the colour of some being purple, approaching to red, and, in others, green, diverging to various shades, and passing, by imperceptible gradations, the one into the other.

The Swedish turnip is of much more recent introduction than the others, but it is by much the hardest species known. It resists well the severities of the weather, the severest frosts being found to have little effect upon it; and, retaining its juices and nutritive properties till a late period in spring, it is highly valued as food for live-stock at that season. The crops of Swedish turnips are not, however, so large as those produced from the white and yellow sorts; but the quantity of nutritive matter, from an equal quantity of each, is so much in favour of the Swede, that it is, in general, considered a more profitable article of culture. It is more difficult to be raised than the other sorts, requiring a stronger soil and a larger quantity of manure. It has a property which the common turnip has not, that of bearing to be transplanted when young, so that when blanks appear in a field, the spaces may be filled up by removing the plants.

A circumstance peculiar to the Swedish turnip is, that the larger the size to which it grows, a given weight of roots is found to contain a greater portion of nutritious matter; while the common turnip, on the contrary, after attaining to beyond a certain size, loses a proportionate quantity of that most valuable part of its composition. This tends to show the necessity for, and the advantages to be derived from, devoting more attention to the procuring of large and well-formed varieties of Swedes, and also to the procuring of intermediate varieties between these and the common turnip, which may be found to combine the size and symmetry of the best varieties of the latter with the above-mentioned valuable property peculiar to the former.

Besides the several sorts enumerated, there are a number of intermediate ones between the Swedish and the Aberdeen, and between the latter and the globe. These varieties, which are termed hybrids, are produced by impregnation as already remarked. This is effected by growing the sorts, of which an intermediate variety is wanted, together, and the impregnation is performed by bees and other insects, which carry the pollen of the one to the stigma of the other; and thus a hybrid variety is produced. In saving turnip-seed, it is therefore necessary to secure a situation for the plants to flower at a distance from any other plant of the same genus in flower, otherwise a hybrid will be produced.

The varieties of the turnip may be multiplied and improved by a careful selection. The manner of securing a good variety of seed is to pick out from the field, in spring, some of the largest and best shaped turnips, with the smallest tops and tap-roots, and to plant them in a separate place in rows. When the plants flower they must be guarded from the depredations of birds ; and just before they are fully ripe, the stems must be cut down and well dried, and then either stored, or thrashed at once, after which the seed is to be preserved in a dry place until the period of sowing arrives. It rarely happens that farmers in this country attend to the saving of seed, either for their own supply or for the market; but, by attention to the preceding observations, seed of the best quality may be secured without adulteration.

The soil for turnips should always be of a light description. In favourable seasons, and with careful culture, good crops may be raised on any soil; but, from the difficulty of removing the crop, and the injury which the land must sustain either in that operation, or in consuming them on the spot, they can never, on heavy soils, be considered as a profitable article of culture. The lighter class of soil are peculiarly adapted to the growth of turnips; but on clayey soils they are frequently cultivated, though on a smaller scale, to be consumed by cattle for the purpose of increasing and enriching the manure into which the straw is converted.

The land for turnips should be well pulverized and cleaned; and this, except in the case of the Swedish, is easily effected, as the soil is light and dry, and the work is performed at an advanced period of the season. After it has been duly prepared, it is to be formed into drills about twenty-six inches apart, and in these the manure is deposited, and covered by reversing the drills as in the case of the potato.

The manure applied to the turnip crop is usually that of the farm-yard, which should be well decomposed previous to its application. This is effected by repeated turnings some time before it is to be applied, as already explained. A liberal allowance should be given. In the common management of farms removed from the means of procuring external supplies, it is found necessary to economize this valuable substance, and much smaller applications are made than would otherwise be advisable. But the culture of the turnip on a large scale is one of the most effectual means of rendering the farmer independent of extraneous manures, by the large supply which its consumption affords.

Lime is also occasionally applied to the turnip crop, but this is more with a view of improving the land than as to any benefit the crop will derive from the application, although it cannot be doubted that it will be benefited by it to a certain extent. The lime may be applied by spreading it upon the ground, and harrowing it previous to the forming of the drills. It may also be applied some time after the plants have made their appearance, and the working of the crop sufficiently incorporates it with the soil. Organic manures, however, are found to be superior to the calcareous for the production of this plant, and all of the former kind may be used with effect.

Bruised bones have been used with the best effects as a manure for turnips, being well suited to the class of soils on which the crop is grown. In the application of this manure the process is somewhat different from that already described. The land is formed into drills, but instead of the bones being spread along the intervals, a rut is drawn along the top of each drill by the plough or the hand-hoe, in which the bones are spread. Machines have been constructed for depositing the bones, which sow the seed at the same time; but on the small scale, the bones may be scattered along the tracks formed for their reception by the hand, the persons employed at the work carrying the bones in baskets or aprons along with them, in which case the seeds are sown afterwards. The whole is then covered by rolling, and in some cases it will be well to draw some of the loose earth over the seed and manure by rakes.

Several other matters are applied advantageously as manure for turnips, of these the chief is a preparation of night-soil, formed by an admixture of quicklime, by which a powder is produced not having the slightest disagreeable smell, and acting as a very powerful manure. It is extensively manufactured in the metropolis and other large towns, and sold under the name of desiccated compost, with the name of the manufacturer or vender usually prefixed. The quantity applied is very small, so great is its effect on the crop, and the mode of application is usually by the hand, the powder being dusted over the seeds in the drills. A greater quantity of the powder comes in contact with the plants by dibbling it in with the seeds at the distance which it is wished the turnips to stand in the drills, observing to drop several seeds into each hole made by the dibber, to guard against failure.

The application of ground bones and other portable substances to soil, as manure for turnips, may be regarded as the greatest improvement which has been effected in the culture of that crop since its introduction into the agriculture of this country, and certainly holds a distinguished place among the numerous improvements by which the agriculture of the country has been brought to its present state. Unless under favourable circumstances with regard to soil and manuring, the culture of the turnip, was frequently hazardous before their auxiliaries were employed. Essential circumstances to the production of good crops, even on soils best adapted to the culture of turnips, were, that the land should be finely pulverized, the seeds placed in contact with the manure itself, applied in a fermenting state, so that the heat evolved during the completion of the fermentative process, should rapidly push forward the young plants. It is still desirable that such should be the case, but in circumstances so adverse that a crop could not be expected under ordinary management, finer crops may be secured by the use of either bones or the desiccated compost, in conjunction with farmyard manure, or used alone. The great object gained by the use of these portable manures is their rapidly pushing forward the young plants beyond the reach of danger, which they are enabled to do by their close proximity to the seeds in the drills. The preferable practice is to use them in conjunction with farmyard manure, in which case a smaller allowance than usual of the latter will suffice. In using either bones or the compost with farmyard manure, it is better that it should be dibbled in with the seed, in preference to the usual plan of scattering both manure and seed equally along the rows.

The operation of sowing is performed by the one-horse sowing machine, which sows two drills each turn; or it may be performed by the turnip barrow, which is pushed along by a man, or fastened to a roller, and sows one drill at each turn. When turnips are cultivated on a large scale the machine should always be employed, as it ensures a degree of certainty and regularity in the process which cannot be effected by any other means, and deposits the seed at a uniform depth. The turnip barrow is exceedingly simple in its construction, and performs the work with great regularity; but it is liable to be turned out of its path by the slightest obstacle in the way.

When turnips are only cultivated in small quantity, as in the case of the cottier and small holder, various methods have been employed for sowing the seed, the use of expensive machines being, in their case, inadmissible. The following plan is at once simple and efficacious:—Let a small tin vessel be procured of a size capable of holding about a pint, through the bottom of which three or four holes are to be made in a right line, large enough to allow a seed to pass through. A lath or other light piece of wood is fastened to this, which serves the purpose of a handle. The manure being covered in the usual manner, a track is made along the top of each drill either by the plough, or by a person drawing a hoe after him along it, for the reception of the seed. When bone manure, however, is applied, the seed is sown directly over the bones. The vessel is now filled about half full, or less, and the sower carries it along the opening in the top of the drill, agitating it at the same time to make the seed come through the holes; and in proportion to the violence with which it is agitated will be the quantity of seed sown. The seed is now covered, as above explained in the case of bone manure, by rolling. It is sown in this manner with the greatest regularity, and the plan, being so simple, is deserving of the attention of those who cultivate the crop on a small scale.

The several operations of forming the drills, spreading the manure, covering it by the plough, and sowing the seed, are to be carried on in close succession. The dung must be immediately covered, that none of its powers may be lost by evaporation; and to promote the early vegetation of the seed, it is to be sown when the earth is newly turned up and moist. The various processes of the turnip culture, thus carried on at the same time, furnish thebest specimen which the culture of the fields affords of the beneficial effects resulting from a proper division of labour.

The quantity of seed sown may be from two to two and a half pounds to the acre. A much smaller quantity would produce the requisite number of plants; but it is necessary to give this quantity of seed, to provide against the loss of plants from the ravages of insects and other contingencies. The quantity should not, however, be excessive; because the plants, when too thick, become feeble, and get interwoven together, and thence become difficult to be thinned in a proper manner.

The time of sowing varies with the different species, those which are the most nutritive requiring the longest period to bring them to perfection, and consequently are to be the earliest sown. The first, therefore, to be sown is the Swedish, the proper seed-time for which is during the second week in May; or it may be from the eighth to the twentieth of that month. The Aberdeen turnips are to be sown from the beginning to the middle of June, and the globe, and other late sorts, from the last-mentioned period to the middle of July. The yellow and white sorts, when sown before the beginning of June, are apt to send forth their flower-stems before winter, by which not only is the soil deteriorated, but the nutritive juices of the root are exhausted. Late sowing has also its disadvantages, as the growth of the crop is active when the winter sets in, and the bulbs never reach their full growth.

After the sowing has been completed, the plants generally make their appearance in six or eight days, according to the state of the weather. When they have assumed what is termed the rough leaf, and are about two inches in height, the process of hoeing is to commence. This is done by a small plough drawn by one horse, going and returning along the interval of each drill, and cutting off a slice of earth from the sides, as near the turnips as possible without injuring the young plants. Or the same operation may be conveniently performed by the horse-hoe with lateral coulters at a single turn. The hand-hoers now follow, and thin out the plants to the proper distances.

In the process of hand-hoeing each hoer takes a drill, and, standing facing the rows, by an alternate pushing and drawing of the hoe from and towards him, thins the turnips, leaving them standing singly at the distance from each other of eight or nine inches. The process of hand-hoeing is one requiring much care and attention in the performance of it. It, indeed, requires attention and manual dexterity rather than strength; and boys and girls are, accordingly, chiefly employed as hoers, but they should be always superintended by an experienced and careful workman. To see this process for the first time, one would suppose the crop totally destroyed; but the turnip plant, with ever so little a hold of the ground, soon recovers its vigour.

Within ten days or a fortnight after this has been performed, the weeds will again spring up. The horse-hoe is then introduced, to cut down all weeds that may have sprung up; and, afterwards, the hand-hoers hoe round the plants, and carefully single out any that may have been passed over in the first hoeing, always observing to allow the stronger plants to remain. This, generally speaking, terminates the operations of horse and hand-hoeing, as the plants now will have got broad leaves overshadowing the ground for some distance on each side of the drills, which will prevent the weeds from growing.

Lastly, after the last hand-hoeing, and when the bulbs of the turnips have attained a considerable size, the double mould-board plough is sometimes passed along the intervals of the rows, for the purpose of making open furrows to carry off superfluous moisture from the land in the autumn and beginning of winter. This operation, however, is not always performed, as it is not found to promote the growth of the plants, and is therefore unnecessary on dry soils.

This, in all cases, terminates the after culture of the turnip. The plants will have attained their full size by the beginning of November, at which time they begin to be given to the cattle, the pastures having failed.

The average produce of the turnip crop may be estimated at from thirty to forty tons to the acre. Forty tons to the acre are a common produce of the Aberdeen and globe; but the Swedish rarely exceeds thirty, unless under peculiarly favourable circumstances.

The crop is consumed by cattle and sheep, for which it forms a wholesome and nutritious food. The Swedish and yellow turnips are also eaten greedily by horses, for which they should be steamed after previously passing through a slicing machine, as no root requires more cooking than the Swedish turnip. Horses will also eat the white turnips, but not freely, unless they have been early accustomed to them.

Turnips may be consumed on the land on which they were produced; and this has, in many cases, been found a beneficial practice, particularly when the soil is but little adhesive, as a degree of consistency is thus given to it which improves it much, at the same time that it is fertilized by the dung and urine of the animals. One great defect of the inferior sort of turnip soils is their want of tenacity, and it is found that valuable crops of wheat may be obtained upon very light porous soils, after turnips so consumed. When turnips are eaten off by sheep on the land, the sheep are not allowed to range over the whole field at first, but are confined to a certain portion by means of netting, or a series of moveable rails or hurdles; and when this is consumed another portion is enclosed. Sometimes only a part of the crop is consumed in this manner, the remainder being given to cattle in the yards. In order to allow the whole surface of the field an equal benefit from the manure and treading of the animals, three rows, or more, are taken up, and the next three allowed to remain. It might seem the better plan to take up every alternate row, but by the former method a passage is made through the fields for the carts without injuring the crop.

In the feeding of cattle the turnips may be removed to an adjacent pasture field, and there consumed; but the proper and regular manner of consuming the crop is to supply the cattle with the roots in the house or open shed, littering them, at the same time, plentifully and regularly with straw.

A portion of the turnip crop is generally taken up and stored in some convenient spot close to the cattle sheds. By storing, the turnip loses a portion of its nutritive juices, and becomes less palatable than when consumed soon after being taken from the ground. The practice is, however, in certain cases, beneficial. It is performed with a view to secure a supply during the time of frost and snow, when the crop is taken up with difficulty; but the chief reason for storing a portion of the crop is to get the land prepared in due time for the succeeding one. Those who have experienced the labour in removing the turnips on wet soils at intervals through the winter, can fully appreciate the value and convenience of having a supply secured before the wet weather sets in.

The white sorts are rarely stored, being usually consumed at an early period of the season; but even were this not the case, they are not suited for storing. The yellow turnips are sometimes stored; but the practice is chiefly confined to the Swedish turnip, which keeps well until the supply of grass comes in the spring.

When the practice of storing is adopted the turnips are taken up in the end of November, or previous to the frosts of winter. The tap-root and the tops or leaves are cut off, each by a stroke of a hook, care being taken not to wound or injure the root. Each person employed in taking up the turnips takes two drills, the bulbs and tops being placed in separate heaps in the same interval. The produce of four drills is placed together, as two persons throw into the same heaps, the one to the right and the other to the left; and the turnips being placed in a right line, a passage is allowed for the carts, without injuring any portion of the crop. The roots are then formed into an oblong heap, the breadth of which may be from five to six feet. It should be raised as high as the turnips can conveniently be placed, it being then less liable to injury from rain; and it is afterwards thatched, and securely bound with ropes. Attention is necessary in cutting off the tops and tap-roots, for if any great portion of either be left, the turnips are liable to vegetate, and if the bulb be wounded in the operation, putrefaction will speedily take place. It is indeed impossible, in practice, to always hit the precise point where they should be cut; the safer way is, therefore, to leave a part of the top and root, rather than incur the risk of injuring the bulb, as it is better to run the hazard of a slight vegetation than of entire putrefaction.

Turnips suffer greatly from sudden alternations of frost and thaw, during the winter. In their frozen state, they are with difficulty eaten by cattle; but they may be thawed, by placing them a few hours in a pool or running stream, or for ten or twelve hours in any warm house in which cattle are kept. In order to have a due supply of roots for cattle in the time of frost and snow, it is always desirable to have a store in the house sufficient for a week or ten days' consumption, rather than have the unpleasant operation of removing the roots from the field, in a frosted state, daily to perform.

The diseases and injuries to which turnips are liable are various. In the early stage, the seeds may not vegetate from a deficiency of moisture; or the young plants may be destroyed by insects, after making their appearance. Should the turnips fail from either of these causes, the sowing is to be repeated. This second sowing, however, rarely answers well; and when the cause of vegetation not taking place is merely a want of moisture, precipitation should be avoided, as the first good shower may cause seeds previously sown to vegetate. Should the failure be only partial, appearing only in particular places, the use of the sowing machine is, of course, inadmissible, as the growing plants would be injured or destroyed while the blanks are being filled up. In this case the tin vessel already alluded to may be employed for sowing the seed, ruts being previously made for it with the hoe.

The fly attacks the turnip when in the seed-leaf, and either totally devours it or partially eats the leaves and centre-bud, so as to impede the progress of the plants to the second, or rough leaves, when the danger is over. Whether the eggs of these flies are deposited on the plants, or in the soil, does not appear to be ascertained; but, in all probability, they are attached to the former, as in the case of the gooseberry caterpillar, and most insects which feed upon plants. Mixtures of old and new seed have been recommended as a preventative, as, from the unequal vegetation of the seeds, it is supposed that some part might escape. Lime and soot are occasionally spread over the surface of the land, just as the plants are appearing above ground, for the same purpose; but the crop being secure when the plants have put on the second, or rough leaves, the greatest security is rapid and vigorous vegetation of the plant.

In addition to the ravages of the fly, the turnips are liable to be attacked by worms of different kinds. Another disease to which it is subject, is a species of canker which attacks the roots; but its presence is first discovered by the leaves becoming flaccid and drooping. The roots, in place of enlarging in their usual manner, shoot away into excrescences. They become acrid, and, even at an early stage of the disease, animals reject them; and, towards autumn, they become ulcerated, and at length decay. A species of maggot is found in them, but whether this be a consequence of the disease, or a cause of it, has not been satisfactorily determined. This destructive disease has been long known in England, and frequently receives the name of "fingers and toes."* Like the other diseases affecting the turnip, it neither admits of prevention nor cure, with any degree of certainty. It may, however, be observed of the diseases to which this valuable plant is subject, that, under favourable circumstances, they rarely occur.

The foregoing account of the culture of the turnip is a description of the practice of the best farmers where it is cultivated for a general crop. Deviations are sometimes made from this practice, when, from the previous occupancy of the land, the crop cannot be sown at a proper season. This occurs in the case of cultivating turnips after vetches cut during the summer, sometimes after flax, and, occasionally, though rarely, after a corn crop.

In each of these cases the land is prepared as soon as the preceding crop is removed, in the manner already described, though the same attention is seldom paid to it, a single ploughing and harrowing being the only preparatory culture given. The whole of the after-management should, as nearly as possible, be the same as in the ordinary culture of the plant, the value of the crop depending, in direct proportion, on the care and attention bestowed on its cultivation.

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* Elements of Practical Agriculture.

For late crops, the only sorts employed are the white varieties. When the seed-time is delayed much beyond the proper season, it cannot be expected that good crops will be produced. Turnips sown so late as the end of July have, however, in many instances, succeeded well, and produced excellent crops; and a crop may be obtained which will make an ample remuneration for seed and labour, even when sown so late as the end of August. The land for this purpose should be dry and light, otherwise the growth of the crop will be effectually checked by the heavy rains which usually fall in autumn.

A tolerable crop of turnips may, in all cases, be obtained after vetches and flax on dry land; but, from the late period at which grain is removed from the fields, it is more hazardous after a crop of that kind. This, added to the severity of the winters, will prevent the culture of turnips after grain crops from being ever practised to any extent; but the subject is deserving of the attention of the cottager, who might thus provide an addition to his supply of green food during the winter and spring months at a trifling expense. The value of the crop would, no doubt, in many cases, be small, but if it exceed, in any degree, the expense incurred in its cultivation, that is sufficient, as the land would otherwise be unoccupied; nor will this treatment tend to exhaust its fertility.

III.—THE BEET.

The beet, *Beta vulgaris*, is of comparatively late introduction into the agriculture of this country, although the garden varieties have been cultivated in it for a length of time, and are well known. About half a century ago, it was brought from Germany to England, and still, in some measure, retains its German name, being usually called mangel-wurzel, and, sometimes, "the root of scarcity," a term which is not in any degree, indicative of the properties of the plant. It was afterwards brought to Ireland, and is now perhaps much more generally cultivated than any of our agricultural plants was, at the same length of time after their introduction—a fact which not only attests the value of the plant, but also shows the great improvement which has taken place among farmers, in being thus ready to take advantage of the valuable properties of a plant, though hitherto unknown.

Although differing so much in size from the beet of the gardens, the cultivated field beet belongs to the same family of plants as the garden varieties. They are distinguished by the latter being darker in the colour, and sweeter to the taste. The field beet is of various shades of colour, though generally of a yellowish white, sometimes internally streaked with red.

This plant will succeed on almost any soil, provided it be rich. It is suited to a greater range of soils than the turnip, and these chiefly of an opposite description. On heavy clay soils, good crops may be obtained, but the preparation of the soil, as well as the after-culture of the crop, is difficult; however, this objection applies equally to any other green crop, and, perhaps, on such soils no other green crop can be cultivated with greater advantage than the beet. It also succeeds admirably on peaty soils, and, in this respect alone, beet is a valuable acquisition to the Irish farmer.

The preparation of the soil is similar to that for the potato and turnip; but it is of importance that the winter ploughing should be deeper than is necessary for either of these crops. After the land has been thoroughly pulverized and cleaned in the spring, it is to be formed into drills, and the manure deposited and covered up by the plough, as before explained.

A liberal supply of manure is necessary for this crop, and it should be well fermented. The space between the drills may be thirty or thirty-two inches. The crop is usually cultivated with the rows closer together, but any economy in this respect is ill judged; for although a greater number of plants may be thus secured, they will be deficient is size, besides the hoeing and weeding are performed with greater difficulty when the spaces between the drills are small.

As soon as the manure is covered, a slight degree of rolling is given, a light roller being employed; and, on the flat surface thus produced, holes are made by a dibble, in which the seeds are deposited. When the crop is cultivated on a large scale, a track is made along the top of the drill, and the seeds are sown along it, and then covered; but the great irregularity in the depth of covering given to the seed, as well as in the distance between the plants, by this mode, is at once apparent, and any additional expense that may be incurred in placing the seeds at the proper distances, and depositing them at the required depth, will be amply repaid by the superiority of the produce. An instrument may be used for forming the holes like a rake-head, by which three or four are made at a time ; and children, following, drop two seeds into each hole. The holes in which the seeds are deposited may be six inches asunder.

The seed of the beet should be fresh, not exceeding a year old, and the utmost care should be taken that it is of the true kind ; for great loss would be sustained should any of the smaller garden sorts be sown. It is difficult to form any judgment from the inspection of a sample of seed ; dependence must, therefore, be placed on the integrity of the seedsman.

The quantity of seed may be from four to five pounds to the acre. A much smaller quantity would produce the required number of plants, but it is better that an additional quantity of seed should be sown, than to incur any risk from a partial failure of the crop. When the seed is sown along ruts formed on the top of the drills, six pounds will be required.

The proper seed-time is from the middle of April to the beginning of the ensuing month. On this subject, however, there is great diversity of opinion ; some farmers sowing so early as the middle of March, and others so late as the end of May. It must be under peculiarly favourable circumstances, that land could be properly prepared at the former of these periods ; but, independent of this objection, we are convinced, from the results of repeated trials, that towards the end of the month of April is the proper season for planting the crop.

When the plants are fully above ground, the horse-hoe, with lateral coulters, or the single-horse plough, is to pass along the intervals. Immediately afterwards, the hand-hoers, with the common turnip hoe, are to go through the plants, to cut down all weeds before them, and, when two are growing together, which will generally be the case, to remove the smaller one. The operation of thinning may be deferred until the plants are about the size of a radish, as a more correct judgment can then be formed respecting those which are to be removed. At this time, any blanks that may appear are to be filled up by transplanting. The beet bears transplanting better than any of our agricultural plants ; and this property has given rise to the practice of sowing the seed in beds, and afterwards removing the young plants to the place where they are to remain. It is, however, certainly questionable, whether this plan possesses any advantages over that of sowing the seed at once on the drills, and it is, besides, attended with a great deal of additional expense.

Under favourable circumstances, the crop will now grow rapidly, but it is to be observed, that the distance between the plants, six inches, is too small to allow them to grow to their full size. As soon, therefore, as the growth of the plants seems to be checked by their proximity, every alternate plant is to be removed, and carried from the field, observing always to allow the healthiest plants to remain. By placing the seeds at the distance of twelve inches asunder at first, the same object would be attained; but the large spaces between the plants were evidently unnecessary during the first stage of the growth of the crop, and a considerable quantity of green food is now obtained without, in any material degree, affecting the total produce.

The same attention is necessary in keeping the land free of weeds, as in the case of the turnip. The last process in the culture of the beet is earthing up the plants slightly with the double mould-board plough, especially on wet soils, to keep the crop dry during the autumn.

As in the case of the turnip, the beet is given to the cattle in the beginning of winter, and it may remain on the land until the crop is consumed, portions being taken up as wanted for use; or it may also be taken up and stored. In cutting off the tops, with a view to storing the crop, care is to be taken not to wound the root, which is peculiarly susceptible of injury in this manner. The leaves also furnish nutritious and highly relished food for every kind of live-stock; and it is a common practice to remove them by the hand, and give them to the cattle before the roots are taken up. A large quantity of succulent food is thus afforded, which the frost would materially injure if allowed to remain, but their removal is not by any means to be attempted until the crop has completed its growth. The roots of the beet are more susceptible of injury from frost than those of the turnip, and greater care is consequently necessary in its preservation on this account.

The produce of the crop is very various, but, under favourable circumstances, it is large, much larger, indeed, than that of any of our cultivated green crops. The average produce may, perhaps, be estimated at fifty tons to the acre, and returns, amounting to sixty, seventy, and even eighty tons have been produced.

Beet root may be given to every species of live-stock with advantage. For a length of time after its introduction, it was given almost exclusively to milch cows, for which it is well suited, being exceedingly nutritious, and causing them to give an abundant quantity of milk, while it does not taint it with the bad flavour which turnips produce. A little more experience in the use of it soon convinced the farmer that it was equally valuable for fattening cattle, and also as food for horses, which are found to thrive well on a daily allowance of it, and to require a much smaller quantity of oats. In an experiment, an account of which was communicated to the Irish Farmer's and Gardiner's Magazine,* it was found that, by giving a stone of the root each day to every horse, one of the feeds of oats might be taken off, and the horses still continue in good condition and at full work. In the same article it is calculated, that from the produce of half a rood of land, if the root is consumed in this way, a quantity of oats will be saved, which it would require two acres to produce—a fact which, of itself, forms a strong argument for the extension of the culture of this plant.

The same correspondent says, that, in the application of this root to the fattening of hogs, he was equally successful, the bacon produced having a peculiarly delicious flavour. In short, no root with which we are acquainted seems to be of so general application.

Besides being used as food for cattle, beet is largely manufactured into sugar in France, and some other countries of Europe. It is not likely, however, that it will ever entirely supersede the cane for that purpose in this country ; but, in the event of a deficient supply being obtained from the colonies, it is of importance to have a resource at home. The produce of a ton weight of the root in sugar will be about one cwt., besides the refuse, which is given to cattle. The produce of an acre of the roots, converted into sugar, would, therefore, amount to a large quantity.

The process of the manufacture of sugar from beet is simple, and could be advantageously introduced into this country, were it not for the protection given to the colonial produce, which amounts to an actual prohibition. The juice is obtained from the roots by rasping and expression afterwards: and this contains the sugar in solution which is obtained simply by evaporation, lime and charcoal being added during the process to free it from the impurities contained in it. After undergoing the refining process, it is difficult to distinguish the produce of the beet from that of the sugar cane.

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* On the Application of Cattle-beet, vol. ii. page 174.

The diseases of the beet are few. Indeed, none of our cultivated plants are less liable to disease.

We have thus been particular in treating of the culture and application of this valuable plant, being convinced that it is well deserving of the attention of the Irish farmer. On the lighter class of soils, it is doubtful whether it possesses any advantage over the turnip; but the culture of the turnip is necessarily confined to these soils, while the beet may be successfully cultivated on the strongest clays, when properly drained and enriched by the application of manures. But the circumstance which renders it peculiarly valuable in this country is, that excellent crops are produced on peaty soils, which are so abundant in every part of the island.

IV.—THE CARROT.

The carrot, *Daucus carota*, is an indigenous biennial plant. In its wild state, the root of the plant is small, dry, sticky, of a white colour, and strong-flavoured; but the root of the cultivated variety is large, succulent, and generally of an orange or straw colour, and shows remarkably the improvement which may be effected by cultivation. Though long known as a garden plant, it is comparatively of late introduction in agriculture. It appears to have been cultivated from an early period in Germany and Flanders, and introduced from the latter country to Kent and Suffolk, in the sixteenth century; but, until the beginning of the present century, its culture was confined to a few districts; however, it is now gradually extending, as the value of the plant is becoming more generally known. In situations suited to the culture of the carrot, it may, indeed, be questioned whether the land can be more profitably occupied than in the production of this crop.

The varieties of the carrot cultivated in the gardens are numerous, distinguished by a difference of colour, size, and form. The most esteemed for agricultural purposes are the Altringham, the orange and the long-red. New seed is most essential, as it will not vegetate in the second year. Old seed, or a mixture of old and new, and also, mixtures of the seed of the horn carrot, which is largely imported, ought to be carefully avoided.

When a carrot is cut transversely, it is found to consist of two parts of different colour and texture. These are the bark and wood; the bark is of the darkest colour and of the most pulpy consistence, and it is also the sweetest to the taste; the heart or wood, especially when the root has attained its full size, is more fibrous or stringy, and if it be separated, it is bristled over with hard points or fibres which extend to the rootlets outside. Almost the whole crown of the root, or the part which sends up the leaves, is connected with the wood, and only the epidermis of the leaves and stem with the external portions of the root.

The skin or bark is found to be more nutritious than the central part, and consequently the value of the carrot as an esculent will depend on the relative proportion of these two parts of the root. The object of the skilful cultivator is, therefore, to obtain the root with the smallest possible proportionate quantity of wood. In endeavouring to secure this result, much must of course depend upon the nature of the plants from which the seeds are obtained; but adaptation of soil is also a very important consideration.

The carrot, from its long fusiform root, requires a deep soil. On soils of an opposite description, its culture should not be attempted. The proper soil is a rich deep sandy loam, of the depth of a foot or more, and equally good from top to bottom; but large and valuable crops may be obtained off peaty soils, or off soils containing a large portion of peat in their composition.

In the preparation of the land for carrots, the ploughing previous to winter should be given with a deep furrow. The preparation of the land is to be continued in spring until it is thoroughly pulverized, and all the vivacious roots of weeds collected and removed. In the case of the carrot, this requires to be performed to as great a degree as for any of the other green crops.

The carrot is sometimes cultivated by sowing the seed broadcast on the surface of the land, as in the case of the corn-crops; but this mode of culture cannot be recommended from the increased difficulty in the after-culture of the crop, as well as the greater uncertainty with regard to the amount of produce. The broadcast system has been practised in the culture of this crop, from an idea, that the seeds cannot be deposited in the drills with a sufficient degree of regularity; but it is difficult to perceive how this objection is removed by scattering the seeds abroad on the surface.

When the row culture is adopted, the seed may either be sown on raised drills, in the same manner as the turnip, or it may be sown in rows on the flat surface. In the latter case, the ground, after being well pulverized, is laid off into drills, at the distance of twelve or fifteen inches from each other, and in the ruts or hollows of these drills the seed is sown, and covered by a slight harrowing. According to this mode of culture, the horse-hoe cannot be introduced, nor such an efficient tillage given, as when the intervals between the drills are larger.

The most approved method of cultivating the crop is, therefore, in raised drills, with intervals of twenty-six inches between them; after the drills are formed, the manure is deposited in them in the usual manner, and, after being covered, the seed is sown.

Manure, according to some, should not be given to carrots the season they are sown; and it is, accordingly, in some instances, spread on the land previous to the first ploughing before winter, and, in others, immediately before the last ploughing in spring. Manure is objected to on the ground, that, when the roots meet with it, they become forked, scabbed, and wormy; but this is chiefly applicable to cases in which recent unfermented manure has been applied, or where it has not been properly spread in the drills. The use of long-unfermented manure is evidently improper, it having a tendency to injure the roots in their growth; but the same objection is not, in any degree, applicable to well-fermented dung. It is admitted, on all hands, that, to produce good crops, manure must be applied at some stage of the process. The application of manure to land before winter, which is intended for green crop, is liable to many objections, and these objections are but partially removed by delaying the period of applying it until before the last ploughing is given; for, even in the latter case, a portion of it is necessarily out of the reach of the plants, and part of it is exposed on the surface. The preferable mode of applying it, then, seems to be to spread it along the hollows of the drills, and cover it before covering the seed.

The seeds of the carrot are extremely light, and cling so close together by means of the forked hairs on their surface, which connect them, that they cannot be separated without difficulty, on which account a peculiar preparation is necessary before sowing. This consists in mixing the seeds with fine sand, and rubbing the mixture well with the hands to separate the seeds from each other. This is sometimes done a considerable length of time before sowing, and if there be a slight degree of humidity in the mixture, it will hasten the germination of the seed.

The drills being formed over the manure, a track or rut is made along the top of them, in which the seeds are sown. They are usually sown by the hand, on account of the difficulty of spreading them equally, but machines of a peculiar construction are sometimes employed. After the seeds are sown, they are to be covered by drawing some of the earth on each side of the rut over it by a rake.

The quantity of seed should depend in some measure on its quality, it being usual to give a larger allowance if this should be suspected to be inferior, as the most frequent cause of the failure of the carrot arises from the badness of the seed. The quantity may be from four to five pounds to the acre, when sown in rows. The seed-time may be from the middle to the end of April.

The young plants are long in making their appearance above ground, particularly in unfavourable seasons; when this takes place, they are hoed to the distance of two or three inches, which is half the distance which the plants are ultimately to be asunder. This operation must be performed with great care, as it is difficult, at this period, to distinguish the carrot from the weeds in the rows. In three or four weeks another hoeing is given, observing, at the same time, to cut down all weeds. The third hoeing is commonly given towards the end of June, or in the month of July; and in this, besides destroying the weeds, another material circumstance to be attended to is, to set out the carrots at the proper distances, and also, where any have been left double at the former hoeings, to take the smaller plants away. The thinnings will now be of considerable value, and are to be carried home to the farmyard. The distance at which the plants are finally to remain from each other may be five or six inches. This, in general, completes the culture of the carrot.

The carrots may be taken up and stored in the beginning of November, or, which is better, they may be left in the ground and pulled up as required for use. In the latter case the flavour and quality of the root are better reserved; but storing is, in many cases, advisable on account of the succeeding crop. When carrots are to be stored they are pulled up by the hand, and put into narrow oblong heaps, and carefully thatched with straw. If taken up when dry, carrots will keep well in those heaps without any other precaution than that of defending them from frost, though they are much less susceptible of injury from this cause than almost any other roots.

It is sometimes convenient to store up a quantity of the roots in the house during the winter season, and large heaps of carrots may be preserved perfectly in this manner. Attention is, however, necessary, in taking up the crop for storing, to observe that in every case the roots are taken up in a dry state, otherwise they are liable to be much injured in the heap.

The produce of the carrot, in circumstances favourable to its growth, will be from twelve to fifteen tons per acre. Double this quantity has been raised in particular instances, but twelve tons to the acre may be regarded as a large crop.*

The uses to which the carrot is applied are various. In the neighbourhood of large towns a portion of the crop is invariably taken to market; but the principal use to which it is applied is as food for the various domestic animals of the farm. Carrots may be given to every specise of live stock, and they form, in all cases, a palatable and nutritious food.

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* The result of experiments communicated to the English Agricultural Society shows, that in situations suited to the growth of the plant, it will prove more productive than any other crop at present in cultivation. The Flemings, from whom we have much to learn in the practice of husbandry, have long been aware of the value of the carrot, and cultivate it extensively as a field plant. A crop of the white or Belgian carrot produced upwards of twenty-six tons to the acre, from seed sown in the second week in April, in flat drills eighteen inches apart, and without any manure. Another experiment reported to the society shows the produce to be nearly thirty-eight tons, certainly an enormous crop, and at the usual price of carrots, affording a return of upwards of one hundred and forty pounds sterling, while the expense of cultivation is not materially different from that of the other green crops. *See Journal of the Royal English Agricultural Society*, vol. ii. p. 40.

The usual application of carrots in the farm is as food for the horses during the winter, and so nutritious an article of food do they form, that when given with cut straw and hay, the animals are kept in excellent condition, and will perform their work without the usual allowance of corn. They are also given to milch cows, and impart a rich flavour to both milk and butter. They form excellent food for pigs, and when boiled, and mixed with farinaceous matters, for poultry. In the distillery, owing to the great proportion of sugar in their composition, they yield more spirit than the potato, the usual quantity being twelve gallons to the ton. The various uses to which they are applied in the culinary art are well known.

The diseases incidental to the carrot are only those which are common to most plants, as mildew, and the attacks of insects. The mildew and worms at the root sometimes injure crops, and are to be guarded against, as far as practicable, by a proper choice of soil, and season of sowing.

The badness of the seed, it has been said, is chiefly the cause of failure of the carrot. This, to a certain extent, can be guarded against, as the farmer can generally save his own seed. For this purpose some of the most perfect and best-shaped roots are selected when the crop is taken up, and preserved in a dry place through the winter, the tops being previously cut off. Care is to be taken, in cutting off the top, not to injure the crown of the root, and it is also of importance to protect the roots from frost. They are to be taken out and planted in February or March, according as the season has become fine. The seed is in no danger of being contaminated by any other plant growing near it, as in the case of the turnip, though the number of plants belonging to the same natural order which are met with in the fields as weeds is great. In August the seed will be ripe, and may be gathered. It is best preserved on the stalks until it is wanted to be used. This is the most certain mode of procuring genuine and new seed, but still it will be found advisable to change it occasionally.

V.—THE PARSNIP.

The parsnip, *Pastinica sativa*, is a biennial plant with a fusiform root, like the carrot, and nearly equal in its products of nutritive and saccharine matter. It is a native of most parts of Europe, and generally cultivated in gardens; but it is only of late and very partial introduction as an agricultural plant.

The cultivated varieties of the parsnip differ from the common or wild sort, in the same manner that the cultivated carrots do from the wild one; that is, by having thick fleshy roots, while those of the latter are small and hard.

The culture of the parsnip has been, for the most part, confined to the island of Jersey, where it attains a large size, and is much esteemed for fattening cattle and pigs. It is considered more hardy than the carrot, and its produce is greater. The large Jersey parsnip is the kind most approved for cultivation, whether in the gardens or in the fields. There are two kinds of it, one of which is shorter and thicker in the root than the other. The seed for agricultural purposes should, if possible, be procured from the island of Jersey, as that of the garden parsnip generally found in seed-shops rarely attains the same size.

The seeds of the parsnip may be sown either in autumn or in spring. The latter period is generally adopted, but the autumnal sowing is well suited to the habits of the plant.

The parsnip may be cultivated on a greater variety of soils than the carrot. The proper soil should, however, be of the lighter kind; but it may be successfully cultivated on soils which are more or less clayey—especially on those which are thoroughly drained, and have received a deep tillage. The latter circumstance is essential for the production of this crop in every situation.

The preparation of the land for the parsnip is similar to that for the carrot; but, instead of preparing it in the spring, a preferable plan would be to prepare it in the autumn, the weather being generally more favourable for conducting field operations at that season than early in spring; and after the preparation of it is completed, it may be formed into drills for the purpose of keeping it dry throughout the winter. When the proper time arrives for sowing the crop the drills merely require harrowing down, and the land is then at once ready for being again formed into drills for the reception of the manure.

Well-fermented manure is necessary for the parsnip, for the reasons already stated in treating of the culture of the carrot, and the mode of sowing is the same as in the case of that plant.

The time of sowing is generally in the beginning of March, as the land will seldom be in a fit state to receive the seed before that time. Although it may be sown in autumn, the spring sowing is in most cases preferred.

The quantity of seed may be from four to five pounds an acre. It must be new, because, when more than one year old, it does not vegetate freely. It is sometimes steeped previous to sowing, to make the young plants come up quickly; but this is not essential, for, at the period at which it must be sown, there is sufficient moisture in the ground to cause germination to take place.

The after-culture is not materially different from that of the carrot, and consists in hoeing and thinning the crop, and keeping it free from weeds.

The crop is ready for use when the leaves begin to decay. It may be taken up and stored like the carrot, or left in the ground, to be taken up as required for use. It is not much liable to be injured by frost, but it should not be left in the ground after the beginning of February, because the flower-stalks will then begin to appear, after which the roots become hard and deficient in nutriment. When stored in heaps, and kept dry, the crop may be preserved without being sensibly deprived of its nutritive properties until the month of May.

The produce is usually much greater than that of the carrot under similar circumstances. Instances frequently occur of thirty tons being produced to the acre, and twenty tons per acre is considered an average crop. The produce will, however, be very variable according to soil and situation.

The crop is applied to the same purposes as that of the carrot. In the fattening of cattle it is found equal, if not superior, to that root; and when this circumstance is taken into consideration, in conjunction with the greater amount of produce, it appears somewhat singular that its cultivation has not become more extended. All animals are fond of the parsnip. The result of experiment has shown that not only cattle, but hogs and poultry, become fat much sooner than when fed with any other vegetable, and that the meat is much more delicious and sweet.

The use of the parsnip, in domestic economy, is nearly the same as that of the carrot. It is much esteemed to be eaten with salted fish, and is indeed a useful vegetable in the garden of the cottager. Like the carrot, it yields a large quantity of spirits by distillation, and it may also be used in the manufacture of wine.

To save parsnip-seed, the process is the same as for that of the carrot. Being more hardy and luxuriant than the carrot, it is less liable to mildew and the attacks of worms; but equally so to become forked, if the soil be not deep and well pulverized, and the manure minutely divided and equally distributed.

VI.—THE CABBAGE.

In treating of the culture of the turnip, we have had occasion to mention the value of the different species of the genus *Brassica*, both as affording large and nutritious supplies of food for man, as well as for the various domestic animals. The cabbage is *Brassica oleracea.* The wild cabbage, from which the cultivated kinds are derived, is a little plant growing upon our sea coasts, and would be altogether undeserving of notice were it not for the numerous and valuable plants whose origin is traced to it, notwithstanding their remarkable diversity of appearance. The Brassica oleracea, and its cultivated varieties, afford another striking proof of the advantages resulting from a careful cultivation, improvement, and selection of the most deserving varieties of our agricultural plants. Nor can a more suitable example be adduced, than to compare this insignificant, weed-like plant of the sea-coast with the gigantic growth of the tree or cow cabbage, the large close head of the Drumhead, or with the different forms or habits of growth in the Brussels sprouts, red cabbage, cauliflower and numerous other varieties adapted for field or garden culture.

The different varieties of the cabbage adapted for field-culture may be conveniently arranged as follows:

1. Those which bear their leaves on stalks, without being formed

into a head. Some of these have crisped leaves, and are a class of hardy pot-herbs everywhere familiar in the culture of the garden. Others have smoothish leaves, with long branched stems. These comprehend the largest and most productive of all the cabbages—the Jersey cole, the thousand-headed cabbage, and others.

2. Those whose leaves are formed into a large head. These comprehend the larger cabbages cultivated in the fields.

3. Those whose roots become napiform, as the Kohl-rabi.*

The cabbages of the first class are much esteemed as garden plants, but they are considered inferior for agricultural purposes. Their leaves are stripped off from time to time as they are required for use; and as these are constantly supplied with fresh leaves, the plants yield a succession of green food throughout a great part of the season, and they continue growing for a great length of time.

The second class comprehends the sorts most esteemed for field-culture. The leaves of these are formed into a head, which is compact, and, in favourable situations, attains a large size. One of these sorts is known by the name of the Large field cabbage, and other esteemed sorts are the Scotch, Strasburgh, and Drumhead.

The remaining class consists of those whose roots become napiform. Of these varieties, the principal is the Kohl-rabi. This plant is cultivated in Germany and the north of Europe, where it is a valuable resource for cattle in winter. It differs most essentially from all the other varieties of *B. oleracea*, in having its stems towards their upper extremity swollen out into a large globular pulpy mass, in consistence and texture somewhat resembling a Swedish turnip, from and near the summit of which the leaves proceed.

Of the different kinds the large field cabbage appears to be best suited for agricultural purposes, as growing to a large size, and forming a nutritious and agreeable food for cattle.

The cabbage may be cultivated like the turnip, being sown in drills, and hoed and tilled in the same manner. The proper method, however, of cultivating the cabbage, is to sow the seeds in the first place in beds, and afterwards to remove the young plants to the situation which they are to occupy. When the seeds are sown at once on the drills, the preparation of the land must then be performed at least a month sooner than if plants from the seed-bed are used, consequently the best month of the cleaning season is lost.

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* Elements of Practical Agriculture.

Any soil that is rich will suit the cabbage, but a strong loam is preferred. It will succeed perfectly well on a clayey soil, and, even in marshy situations, large crops have been raised. The chief particular to be attended to is, that the soil be rich, either naturally, or by a liberal application of manure.

The land intended for cabbage, after being sufficiently prepared, is formed into drills, in which the manure is deposited, and afterwards covered by reversing the drills, which are then ready for the young plants. The distance between the drills may be twenty-six inches.

For the purpose of procuring the supply of plants, the seeds must be sown as early in spring as the weather will permit. The seeds are usually sown in beds about four feet broad; and, if the goodness of the seed can be depended on, it is sown rather thin, and covered lightly with well-pulverized earth from the alleys between the beds. This should have been done in March, and, about the middle of May, or as soon afterwards as possible, the plants are placed in the drills. About a quarter of a pound of seed will be sufficient to produce plants enough for an acre.

After the young plants are taken from the seed-bed, and immediately before planting, the extremity of the root is sometimes pinched off, but this is by no means essential. It is, however, found necessary to pick off any tubercles, or excrescences, that may appear on the root, as these generally contain worms, which, if allowed to remain, would greatly injure the plants. Immersing the roots in a mixture of urine and earth, or dung, is also useful to protect the fibres and pores of the root and stem from drought. The plants are then set in along the tops of the drills by the dibber, at the distance of twenty inches, or two feet between each plant. Care must be taken in this operation not to place the plants too deep, and to press the earth firmly about the lower extremity of their roots. This is effected by sinking the instrument into the ground on each side of the plant in a slanting direction, which fills up the original hole formed for the reception of the root of the plant. If this last point is not attended to in planting with the dibber, the plants will either die, or, if kept alive by the moisture of the soil or rains, their progress will be very slow. Notwithstanding all the care that can be taken, the plants will droop for awhile after planting, especially if the weather remain dry, in which case, watering would be advisable; but when the planting process is properly performed, they will soon recover.

The after culture of the cabbage consists in tilling the intervals between the rows for pulverizing the soil and destroying any weeds that may spring up. The crop usually continues to grow during the early part of the winter, and is consumed by the cattle in the spring. When intended for consumption in the beginning of winter, the seed should be sown in the previous autumn, and planted out in the drills in the month of May.

The cabbage does not bear storing like the turnip, and, therefore, the crop must be taken up as it is consumed. Cabbages are taken up by cutting off the heads with a hook or knife; but the roots should not be allowed to remain any considerable length of time afterwards in the ground, as they send forth a profusion of shoots, which rise to seed, and thus exhaust the soil in a great degree. They may be boiled or steamed, but they are usually given in a raw state. They are relished by all feeding animals, but they are chiefly valued for the feeding of milch cows.

It is no uncommon thing to raise single cabbages that weigh upwards of thirty pounds; and even supposing the average weight of each to be far short of that amount, a very large return would be produced to the acre. Thirty tons may, perhaps, be regarded as an average produce of this crop.

The cabbage is more nutritive than the turnip, and will support a greater number of animals from a given extent of land; but its culture is more hazardous, and attended with greater expense. It cannot, however, be properly compared with the turnip; for while the latter is suited to the lighter soils, the former succeeds only on those of an opposite description. In this respect it bears an additional value, and may, with propriety, be cultivated on those soils which are unsuited to the growth of turnips. On clay farms, it has been seen, that turnips cannot, with advantage, enter largely into the course of cropping, and the same remark applies equally to most of the plants included in this chapter; and, in this case, the culture of the cabbage may be advisable. To the cottager and small farmer, the culture of the cabbage may be recommended with the greatest propriety; and, in the various plans that have been proposed for supporting the greatest number of cattle on a given extent of land, as suited to this class of our population, the cabbage invariably occupies a distinguished place.

To save cabbage-seed, select a few fine specimens, and plant them by themselves, where they will be in no danger of being contaminated by others of the Brassica tribe when in flower. The seed, if properly preserved, will keep for many years.

The diseases of the cabbage are the same as those of the turnip, with the exception of the forked excrescence. On the roots of the plants are frequently found knobs, which, in the preparation for transplanting, should, as has been already observed, be carefully removed.

VII.—RAPE.

Another important plant of the Brassica tribe is the rape. It is an indigenous biennial plant. There are several varieties of rape which may be cultivated, either distinguished by the roughness or smoothness of the leaves, or by producing a fusiform root. The variety best adapted for cultivation in this country is the smooth-leaved rape, which produces abundance of both leaves and seeds. The fusiform-rooted variety of this plant is but partially cultivated, the produce being small, either for the feeder or oil manufacturer.

The rape is a hardy plant, and has a wider range of soils than the turnip. It may, indeed, be grown with advantage on almost any description of soil, although the value of the crop will depend on the state of the land with regard to fertility. It is well suited to peaty soils, and is, in many cases, the most profitable crop that can be produced on newly broken-up land.

The manner of cultivating rape is very similar to that of the turnip, when it is grown for its roots and leaves; but it is somewhat different when the object in growing the crop is for its seeds. In the latter case, much more care and attention are necessary, and an earlier period of sowing must be adopted. The most valuable application of the crop in this country is as food for cattle and sheep, our climate being too precarious to depend on saving the seed.

The preparation of the land for rape may be the same as that for the turnip; and, after being duly prepared, it is to be formed into drills, manured, and the seeds sown precisely as in the case of the turnip, but with much narrower intervals between the rows. The seeds may also be sown in rows upon a flat surface, the manure having been previously incorporated with the soil, by spreading it on the surface of the land previous to the last ploughing, and then ploughing it down. When manure is applied to rape, the better plan is, however, to form the land into raised drills, as the plants have then the full benefit of the manure, and, being completely covered, its effects are more powerful and permanent.

The season of sowing should be nearly the same as for the later varieties of turnips; but it admits of being sown much later than the turnip, and, therefore, when the land cannot be prepared in a proper time for that plant, rape may be grown. Rape may be sown at almost any period from the end of July to the end of September; and, under favourable circumstances, a large quantity of green food may be secured for consumption in the spring, even when sown at the latter period. The quantity of seeds may be from four to five pounds an acre.

The manure commonly applied in the cultivation of rape is that of the farm-yard; but, instead of this, bruised bones may be employed, Rape dust may be also used, with good effect.

The after-culture of the rape nearly resembles that of the turnip. The crop is to be hoed after the plants have come above ground, and fully assumed their second leaves. They are then thinned out to the distance of five or six inches from each other, and the weeds are to be kept down during the growth of the crop. The plants bear transplanting well, and advantage may be taken of this property to fill up any blanks that may appear.

This method of cultivating rape is adopted when it is grown as a rincipal crop; and when the culture of it is conducted in this manner the produce will be large. But rape is frequently grown as an intermediate crop, by which a second crop is obtained from the land in the same season. Thus after the removal of the oat crop, a tolerable crop of rape may be produced in the succeeding spring, by merely sowing the rape seed on the newly turned up furrow of the oat stubble. After flax, and early potatoes especially, a good crop may be expected, as either of these is removed sufficiently early off the land or the purpose; besides the land is left in a good state for the young rape plants.

When rape is cultivated as an intermediate crop, the culture may be more simple than that already described. A single ploughing is generally considered a sufficient preparation for the seeds, which are then sown broadcast along the surface. But, as rape is found to bear transplanting well, the preferable plan is to sow the seeds in a bed in the month of July, and the plants will have attained a considerable size before the crop to which they succeed will have been removed from the land.

The plants are sometimes, in this case, put into the ground at the same time that the land is ploughed, being placed at regular distances along every second or third furrow-slice, according to the distance which it is intended the rows of plants should be asunder, and the plough, following, covers the roots of the plants with the next furrow-slice, and so on, until the whole is finished. This mode is expeditious, but it is defective in this, that the earth is not properly pressed to the roots of the plants; but it is less so than if it had occurred at an earlier period of the season, as the plants are less liable to suffer from drought. To remedy this defect, the plants may be put into the ground by the dibber, the land having been previously well harrowed after ploughing.

Rape is chiefly prized as food for sheep. The stems and leaves of the crop, as food for these animals, are scarcely surpassed by any other vegetable, in nutritious properties, and in being agreeable to their taste. The crop is fed off occasionally from the beginning of November to the middle of April, being found of great value in the former period for fattening old sheep, and, in the latter, for supporting ewes and lambs. It also affords excellent food for milch cows, causing them to give an abundant supply of milk.

But the rape, it has been said, is frequently cultivated for its seeds both for the purpose of reproduction, and being manufactured into oil. In this case, it is to be regarded as an exhausting crop, the leaves affording but a small quantity of manure, and they are sometimes burned for the potash they contain. When the plants are allowed to ripen their seeds, the proper season for sowing is in the summer, or early in autumn, as when cultivated for forage, and they will ripen their seeds in the following summer.

In this case, the crop comes into flower in the succeeding May, if the season has been favourable; and in the month of July the seeds will be ripe, after which no time is to be lost in reaping the crop, that no loss may be sustained by the shedding of the seeds. To prevent this, it is usually thrashed before being removed from the field, if the weather be fine, a temporary thrashing board being formed, with winnow-cloths spread underneath.

Besides the green leaves of rape being used for feeding sheep and cattle, they, as well as horses, are found to eat the smaller dry twigs, or branches of the plants, with avidity, after the ripe seed has been thrashed out; and the thicker portions of the stalks may be employed as litter. This practice of disposing of the straw, or offal, yields a greater return of manure, and is, therefore, deservedly recommended as preferable to that of burning it, as is generally done by such as grow the seed for the oil manufactory.

XI.—CULTURE OF LEGUMINOUS PLANTS.

The culture of the leguminous field-plants, the seeds of which are used either as food for man or cattle, forms but a very inconsiderable portion of the labours of the husbandman in this country. A field of beans or peas is only occasionally to be met with, even in the best cultivated districts; and, although a corner of a field sown with vetches is more frequently seen, yet the quantity is much smaller than is consistent with a good system of husbandry in our climate. The small space devoted to the culture of this class of plants proceeds, in a great measure, from ignorance respecting their habits of growth and modes of culture, as well as the advantages to be derived from their cultivation.

The seeds of the cultivated legumes are considered to be the most nutritive of vegetable substances grown in temperate climates. They contain a large portion of matter analogous to animal substances, having, when dry, the appearance of glue, and being as nourishing as gluten. On the Continent they supply, to a great extent, the place of animal food to the working classes; and, in Germany, it is stated, that the labourers are dissatisfied unless they receive a meal of legumes at least twice a week.* The straw, or haulm, when cut before it is dead ripe, is more nourishing than that of any of the cereal grasses. But leguminous plants are not only more nourishing to man and animals, but even to vegetables they may be said to supply food; since they are not only known to be less exhausting to the soil than most other plants, but some of them have been ploughed down in a green state for manure from the earliest times. When cultivated for their seeds, they, doubtless, exhaust the soil in a greater or less degree, but much less than the cereal grasses. The cultivated leguminous plants deserving of notice in this country are the bean, the pea, and the vetch or tare.

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* Encyclopædia of Agriculture.

I.—THE BEAN.

The bean belongs to the genus *Vicia*, of which there is reckoned but one species adapted to field-culture,—

Vicia Faba—Common cultivated bean.

Great diversities in the habits and appearance of the plant have been produced by the effects of climate, soil, and culture. There is, perhaps, no other grain, over the shape and colour of which these circumstances have so much influence as in the case of the bean. Thus, in a warm dry summer, the sample is always plump, and white in colour, particularly if followed by a dry harvest, and more so when cultivated on a strong rich clay, than on a light soil, and when drilled than when sown broadcast. But the great diversity of appearance in some samples of the common bean, is owing more to a mixture of varieties than to any other cause. That such a mixture exists is rendered apparent by examining a field of beans in full flower, when they will be seen to present an infinite diversity in the colour of their flowers; and, although this may not, and does not always precede a different colour or form in the seed, yet it, doubtless, constitutes a variety, and, therefore, the seeds are more likely to vary than if the flowers were all the same.

The varieties of the bean cultivated in the garden are numerous, but those cultivated in the fields are comparatively few. The characters of these two classes are well defined—the field beans being grey, and the garden beans white; although the white varieties are sometimes cultivated in the field, and the grey sorts occasionally, though rarely, in the garden.

Of the white or garden-beans sown in the fields, the mazagan and the long-pod are almost the only sorts. Of the grey or field-beans, that known as the horse-bean, the small or tick-bean, and the Heligoland, are the chief sorts. A variety is cultivated in some parts of England, called the winter-bean, recently introduced from the Continent, which is planted in October in the usual manner, and is ready for cutting down in the end of July, or beginning of August.

The mazagan, and the long-pod, though chiefly confined to the gardens, are sometimes cultivated in the fields. The kinds, however, most important to the farmer, and forming the subjects of common cultivation in the fields, are the grey varieties. The horse-bean is generally considered more hardy than the tick; but the latter is regarded as of better quality, and more productive. The Heligoland is but a short time cultivated in this country, but it seems a valuable variety, being very productive.

In the choice of sorts, attention should be paid to the time of ripening, as well as to the productiveness of the crop. The late period at which it is ready for harvesting, is more against its cultivation in our variable climate, than any other circumstance; and a variety which would remedy this defect, by ripening a few weeks earlier, would be much more valuable. On this account, the winter-bean already mentioned is deserving of attention. In the selection of beans for seed, care should be taken to choose such as are hard and bright, without being shrivelled in their appearance.

The best soils for beans are clays and strong loams. They are sometimes cultivated on light soils, but such soils are, by no means, proper for them, those to which they are adapted being of the heavier class. In the rotation of cropping, the bean is regarded as well suited to prepare the land for wheat, and its value as an agricultural plant depends, in a great degree, on this circumstance. Before bean cultivation was introduced on heavy clay soils, the summer-fallow was considered indispensable in the preparation of them for wheat; but it has been found that, from the complete tillage which the bean admits of being given to the land during the growth of the crop, it is a good preparation for a corn crop, and, when combined with thorough draining, it bids fair to supersede the necessity of a naked fallow, at no distant day. The introduction of turnips into common cultivation enabled the farmer to dispense with the summer-fallow on the class of soils to which that crop is adapted; and what was effected by turnips on the lighter class of soils, will be effected by beans on those of an opposite description.

In the preparation of the land, much depends upon the nature of the soil, and the state of the weather; for, as beans must be sown early in spring, it is often impossible to give it all the culture which a careful farmer would wish to bestow. In all cases it is to be ploughed with a deep furrow after the harvest, as in the case of the summer-fallow, and the preparation of the land for green crops; and similar precautions are to be taken for preserving the land in a dry state during the winter. As early in the spring as it is sufficiently dry to be worked, the preparatory operations of ploughing, harrowing, and gathering weeds, are to be commenced, and carried on until the soil is well pulverized and cleared of weeds. At this period of the season, however, these objects can be but imperfectly attained, and frequently a single ploughing is all the tillage that can be given; but a second one will be highly advantageous, and should never be omitted when the land is in a state to receive it without being injured by the treading of the working cattle.

Beans should, in every case, be cultivated in rows. Though still sown broadcast in several places, and sometimes dibbled, they are for the most part drilled by judicious cultivators. They are, in many cases, deposited after the plough, and covered by succeeding furrow-slices; and by this method the crop rises in rows of eight, sixteen, or twenty-four inches asunder, according to the size of the furrow-slice, and the number of slices intervening between each deposition of seed. The seeds are sown by a machine attached to the plough, and the operation frequently takes place when the land is ploughing from stubble, a single ploughing only being given. The crop is afterwards kept clear of weeds, and the spaces between the rows pulverized by the horse or hand hoe. This method is expeditious, and may, in many cases, be adopted from necessity, it being impossible to have the land otherwise suitably prepared in due time; but it is slovenly in the extreme, and neutralizes, in a great degree, the advantages to be derived on heavy soils from bean culture.

Dibbling the crop at regular intervals in the rows is an excellent mode of depositing the seed, and one well calculated for the small farmer, as the saving of seed will more than counterbalance the additional expense incurred by the process. The manure is first deposited and covered up, and on the top of the new drills thus formed, holes are made into which the seeds are dropped, and they are afterwards filled by rolling. When beans are cultivated to any considerable extent, however, dibbling is obviously impracticable.

Manure is generally applied to the bean crop, and this should be the case in every instance when wheat is to succeed. The manure may be spread upon the land previous to the first ploughing in the autumn, but the better plan of applying manure to the crop is to lay it in the drills immediately before sowing the seed.

The preparation of the land for beans may take place in the autumn, and this is, in many cases, the preferable practice. The land is more easily pulverized and cleared of weeds in that season than in the month of January or February, when it must otherwise take place. A sufficient number of ploughings and harrowings are given to reduce it to the required tilth; and it is then formed into drills, in which state it remains until the period of sowing arrives.

The season of sowing should be as soon as possible after the severity of the winter is over; for the bean, being a slowly-ripening plant, should be sown as early as circumstances will allow. The month of February should be selected if possible, and the sowing should not be later in any case than the middle of March, as the ripening of the crop and its safe harvesting would otherwise be precarious in our climate. They are also sometimes sown previous to winter, though the practice is not suited to a cold and humid climate.

After the manure has been regularly spread along the intervals of the drills, the beans are to be sown, either by the sowing machine or by the hand. When the bean is cultivated on a large scale, the former method will, of course, be employed; but the seeds may be scattered along the intervals with a sufficient degree of regularity by the hand. The beans are covered by reversing the drills. The distance between the drills may be twenty-six inches.

The quantity of seed will depend on the soil, and the variety cultivated. From three to four bushels to the acre may be taken as the average quantity; however, in some cases, a much smaller quantity has been employed, especially when the dibbling process is used. When beans are sown or planted thick, the pods fill only partially to the top of the stalk; but, when thin, the plants will pod and fill to the bottom. Whatever method of sowing is employed, it is a common practice to mix a small quantity of peas along with the beans. The quantity of peas added must depend on the nature of the soil, as, strictly speaking, peas cannot be grown on bean soils to advantage.

The after-culture of the bean commences with harrowing just before the young plants reach the surface. This operation takes place ten or twelve days after the beans have been sown. The process of harrowing should be resorted to in all cases of bean culture, and if it cannot be done immediately before the appearance of the plants above ground, it may be delayed till a little after it. This may appear a rude operation, and yet it is never hurtful, as it is found to check the growth of the weeds, and to promote the vegetation of the plants, by the more intimate comminution of the particles of the soil. The harrow employed may be that used for covering the seeds of the gramineous and other forage and herbage plants. In cases where the operation has been delayed until the young plants are considerably above ground, the harrow used for harrowing potato drills, figured in page 323, may be used with good effect.

This process of harrowing being performed at an early period of the season, and the ground being laid comparatively flat, the crop may suffer much from water stagnating on the surface, if the cross channels are not properly cleaned out to afford it a ready egress off the field. This is rendered the more necessary from the circumstance of beans being chiefly cultivated on the heavier class of soils.

After the crop has made some progress sooner or later according to the state of the weather, and that of the soil with regard to weeds, the horse-hoe is employed in the intervals between the rows, and followed by the hand-hoe for cutting down such weeds as the former cannot reach. In the first hoeing to be given to the plants, the single-horse plough may be employed, which, passing along the intervals between the rows, makes a shallow furrow on each side as near the rows of the plants as the plough can go without injuring them, laying the furrow-slices towards the centre of the interval. The weeds which escaped the action of the plough or horse-hoe being carefully cut down by the hand-hoers, the whole remains about ten days in this state, when the hoeing operations are again repeated, and continued until the earth between the drills is well pulverized and the weeds all cut down. Shortly after these operations have been finished, the double mould-board plough passes along the centre of the intervals, so as to lay up the earth close to the plants. The advantages resulting from this earthing-up are, however, said to be counterbalanced by the trouble which it occasions in harvest, by rendering the surface uneven. It is not, certainly, an essential part of the process, and it may be dispensed with unless the soil is very wet and level. This generally completes the culture of the crop.

In unfavourable seasons this crop hardly ever ripens effectually ; and it is exceedingly difficult to get the straw in a proper condition for the stack. To hasten the process of ripening it has been found of advantage to cut off the succulent tops of the beans, which, it is said, occasions the crop to be ready for reaping a fortnight earlier.

The harvest of beans is, at all times, an object of anxiety, in consequence of the danger to be apprehended from the changes of weather which may be expected to occur at that season, and the serious injury to which the crop may be thus exposed before it can be got into a fit state for removal to the stack. Loss may be sustained in hot weather by the shedding of the pods, if the crop be allowed to stand upon the ground until it is fully ripe; and care must also be taken, in the different processes of the harvest, in order to secure the full produce. The period of ripening is also, in many cases, unequal; for, in late seasons, the plant sometimes takes on a second growth. When a portion of the crop is not thoroughly ripened, the pods will shrink, and their quality be impaired; and, if allowed to become over-ripe, an equal loss may be sustained by the scattering of the grain. The latter circumstance, however, takes place more rarely than the former, as, in many cases, the crop can scarcely be got thoroughly ripened. Under these circumstances it is unnecessary to let the beans stand uncut after the beginning of October; because any benefit that may be gained afterwards is not to be compared with the disadvantages that accompany a late wheat seed-time.

Beans may be cut either by the scythe or by the sickle. They should be cut as near the ground as possible, for the sake of the straw, which is of considerable value as fodder, and because the best pods are often placed on the lower part of the stem. It is proper to let the sheaves lie untied for several days, if the weather be fine, so that the winning process may be hastened; and, when tied, to set them on end, in order that full benefit may be derived from the air, and the grain kept off the ground. The sheaves are bound with a straw rope, or with a single length of wheat-straw, which is better; or, when pease are mixed with the beans, by ropes formed of the stems of the pease twisted upon the spot at the time of reaping. Twelve or fourteen sheaves may be put in each stook, as in the case of the cereal grasses, but without the hooding sheaves.

In unfavourable seasons, when there is a probability of the crop remaining a considerable time in the stook, it has been recommended to remove the crop, and stook it in an adjoining field, so as to ensure the sowing of the wheat in due season.

The beans, when fully ready, are taken to the stackyard, and formed into round or oblong stacks. A funnel through the centre of the stack, to which there is free access of air from the bottom and sides, especially if the stack be large, will be found necessary to preserve the crop from injury. The beans may, in the first instance, be formed into an oblong pile of only a sheaf in breadth, raised to the height of eight or ten feet, and covered with straw on the top to keep off the rain. In this state the air has free access to every part of the crop, and on the beans becoming thoroughly dried, they may be formed into a stack better calculated to protect them from injury, if they are to remain long unthrashed.

The thrashing of beans may either be effected by the thrashing machine or by the flail, and the mode of dressing is the same as in the common process with other grains. Thrashing by the flail is, however, the mode generally adopted by those farmers who give the haulm as food to working horses, as its succulence, when thus gradually thrashed, is better preserved than when a large quantity of it is prepared together by the machine.

The produce of the bean depends more upon the state of the soil and the weather than any other grain crop, and is, from these circumstances, exceedingly various. Forty bushels to the acre are regarded as a good crop, and twenty as an inferior one. In some cases the produce has been considerably greater than the former, while in many others it has not much exceeded the latter. The produce of haulm may, in general, be taken at two tons to the acre.

Beans are chiefly cultivated as food for horses, but they are also sometimes largely given to other animals, in which case they are usually manufactured into a coarse kind of meal. The flour from beans is more nutritive than that of oats, as appears from the fattening of hogs; whence, according to the respective prices of these articles, it is considered that peas and beans generally supply a cheaper provender than oats, for horses as well as other domestic animals. From the peculiar oily matter, however, which is contained in the bean, it is considered more difficult of digestion.

The straw of the bean, when properly secured, is nutritious and wholesome. When mixed with that of peas it is little, if at all, inferior to hay. It should either be given when newly thrashed, or else stacked up and well compressed, as the air is found to affect materially both its flavour and nutritive properties.

The bean is a plant very subject to disease, and in an especial manner to injury from the attacks of insects. These are most injurious in dry weather, and being chiefly confined to the tops of the plants, it has been recommended to cut them off, which may mitigate the evil; but, in general, it is without remedy.

II.—THE PEA.

The pea is the most esteemed legume in field cultivation, both for its seeds and haulm. It has been partially cultivated in various parts of the United Kingdom from the earliest times, though the extent of land appropriated to its culture seems to be on the decrease since the more general introduction of herbage plants and roots. There are various inducements, however, to the cultivation of peas on dry warm soils, particularly in the vicinity of large towns; for when the crop is good, and gathered green, few pay better; and, after it is removed, the land is readily prepared for turnips.

Of the pea there seems to be but one species, from which the great number of varieties suited to field and garden culture were produced, namely,—

Pisum sativum—Cultivated Pea.

But the pea family has often been considered as including two species, *Pisum arvense*, and *Pisum hortense*, an arrangement which may be considered as founded rather in convenience, so far at least as regards the different purposes for which they are cultivated, than from any specific distinction existing between the plants. Their botanical characters are not, indeed, sufficiently distinct, nor permanent in their duration, to admit of their forming two distinct species; but, as the varieties in cultivation are so numerous, some mode of classification seemed to be necessary in order to admit of more easy reference; and for this purpose the arrangement just alluded to seems to have been adopted.

The changes produced on this plant by climate, soil, and culture, are very great, and hence the origin of the numerous varieties in cultivation. The different sorts may, however, be divided into two classes—those grown for the ripened seed, and those grown for gathering in a green state; and these distinctions are further indicated by a difference of colour, the former being in general grey, and the latter white. The white are usually cultivated in the gardens, and the grey in the fields.

Sometimes peas are cultivated to be used in their green state, and there is no species of cultivation more profitable than this, when it can be adopted; for the peas being ready for use in the month of June, time is allowed for taking another crop, generally of turnips, in the same season. When the cultivation of the pea is practised, having recourse to early sorts is, therefore, of considerable importance in the economy of the farm, as the seeds may be even ripened in time for a succeeding crop, and the peas be cut and secured while there is leisure before the commencement of the grain harvest. These circumstances being taken into account, it appears that the cultivation of the pea might, in many cases, be extended with advantage; and there is no doubt that it is deserving of a greater share of attention than has hitherto been bestowed on it in this country.

Though taking up the crop in a green state under peculiar circumstances has been found a profitable method of disposing of the produce, the general purpose of cultivating the pea is for its ripened seeds. When these are intended for boiling, the white kinds are used; but when for the food of horses and other animals, the grey kinds are preferred.

The superior attention devoted by horticulturists, compared with that of agriculturists, in procuring and proving the different plants under their care, is perhaps more clearly exemplified in the case of peas than in that of any other tribe of plants whatever, as may be seen by comparing the number of white-blossomed, or garden peas, in cultivation, with that of the purple-flowered, grey, or field sorts; and the beneficial results arising therefrom serve as a stimulus for cultivators to persevere in the improvement of such sorts as are found to be best suited for field culture. Several varieties are cultivated on the Continent, and are found very productive, which are altogether neglected in this country.*

* An account of Knight's interesting experiments on the pea, by which so many valuable varieties were produced, will be found in various papers in the Transactions of the Horticultural Society.

The period of sowing peas must vary considerably, according to the intentions of the cultivator, and the varieties employed. The late-ripening kinds are usually sown in February or March ; the early-ripening kinds in April, and sometimes so late as the beginning of May.

The soil for peas should be of the lighter class, and of a nature neither too much exposed to humidity nor to drought ; but the pea will grow on stiff soils as well as the bean, and it has been known, in some seasons, to succeed on strong clays. These are not, however, the proper soil for peas, as they are adapted to the sandy or gravelly soils, and to the calcareous rather than to the siliceous. In all cases a mixture of calcareous matter is so highly favourable to their growth, that marl or lime is always found to forward a crop more than any other kind of manure.

The proper place for peas in the rotation of cropping is after a corn crop. The pea is sometimes the first crop on newly broken up grass land ; but this cannot be regarded as its proper place in the rotation. When the land has been carefully cultivated, it will be found in a good state for a corn crop after peas ; but in this case advantage is not taken of its early ripening properties, by the production of a second crop in the same season.

The preparation of the land for peas is similar to that already described for beans; but there is not the same necessity for deep tillage as in the case of the bean.

Peas are sown either broadcast or in drills. The broadcast system is that generally employed ; but it is obvious, that according to that mode of tillage, this cannot be regarded as a cleaning crop. The drill system is, therefore, to be preferred, not only as it affords a better opportunity of cleaning the soil, but the produce is generally found superior both in quantity and quality. After peas cultivated in drills, the land will also be in such a state of preparation for turnips, as only to require a slight ploughing, which may be given as soon as the pea-crop is removed, and the turnip seed may be drilled in as quickly as possible upon the newly turned-up earth.

The land being properly prepared, and pulverized for the reception of the seed, it is to be sown when the proper season arrives. The seeds may be sown on the flat surface by the common corn-drill machine, the orifices being adapted to the larger size of the seeds ;

or the land may be formed into drills, as in the case of the bean, and, after the seeds are sown, it is to be harrowed across, instead of splitting the drills, by which a sufficient covering will be given. The seeds are also sometimes covered by the plough at the same time the land is being ploughed, when they are deposited in every second or third furrow; and sometimes in every furrow, in which case, the rows are only eight or nine inches asunder. This last method is, however, decidedly inferior to either of the preceding. The rows should, in every case, be twenty-six inches part.

Manure is rarely applied to this crop, nor is there any necessity that it should, when a crop of turnips is to succeed. When a corn-crop, however, succeeds, it is necessary that manure should be applied to the pea-crop, or immediately after it is taken off the land. In the case of applying manure to the pea-crop, it is spread over the land, and covered by the plough before winter, rather than in spring, as the application of manure directly to the crop, causes it to run too much to straw. But if the soil be deficient in calcareous matter, lime or marl may be applied with good effect to the pea-crop.

The quantity of seed must vary in different cases and circumstances, according to the time and manner in which the crop is put into the ground; but, in general, it may be from two and a half to three bushels to the acre, the early sowings having the largest proportion of seed. Steeping the seed is never practised as a preventative of disease, but it is occasionally performed with late sowings to hasten the process of germination. To the seed of the early-sown varieties, a proportion of beans is usually added; and this is a good practice, the tall and erect stems of the beans affording a support to the other. It is for this purpose alone that beans are sown, and not with a view of increasing the value of the crop by the produce of the beans. The seeds are easily separated after being thrashed, being of such unequal size.

The after culture given to peas is that of hoeing and hand weeding. These operations are commenced when the plants are a few inches above ground, the intervals between the drills being pulverized, and the weeds growing among the crop destroyed; and they are repeated shortly before the plants come into flower. From the rapid growth of the crop, one hoeing only can be given in certain cases, but the second is always beneficial where practicable. It is also of importance that the tillage should be commenced at an early period, as the pulverization of the soil is found to promote the growth of the crop in an especial manner. When the operation is properly performed in the first instance, little difficulty will be experienced in repeating it, as from the rapid growth of the crop, the weeds will make little progress after the first hoeing is given.

When pea-crops become ripe, they wither and turn brown in the haulm, or straw, and the pods begin to open. In this state, they should be immediately cut, in order that the loss sustained by their shedding may be as little as possible. The process of reaping is performed with a tool called a pease-make, which is merely the half of an old scythe fixed in a handle; and, in some cases the sickle is employed. After the crop is reaped, it is the usual practice to put it up into small heaps, called wads, which are formed by setting small parcels against each other, in order that they may be more perfectly dried, both in the seed and stem, and be kept from being injured by the moisture of the ground. When wet weather occurs during the time the pease lie in wads, it occasions a considerable loss, many of them being shed in the field, and of those that remain, a great part will be so considerably injured, that the sample will be of little value. The harvesting of the early varieties, however, is attended with little difficulty. From the early period of ripening, it is seldom considered necessary to bind up the crop; the haulm is merely hooked, or collected into heaps, which as soon as they become dry, are removed to the stacks.

The thrashing of peas is attended with less difficulty than that of any other crop. When the haulm is to be preserved the work is better done by the flail, as the thrashing machine reduces it greatly to chaff; but when it is for immediate consumption, the breaking of it is no disadvantage.

The produce of the pea is very uncertain. It is also subject to greater fluctuations, in point of price, than any other grain. From thirty to forty bushels per acre may be regarded as a good crop, though, perhaps, the average produce is somewhat below that amount. The produce in straw is also very various, but, in general, it is much more bulky than that of the cereal grasses.

The chief application of the pea, like the bean, is for horse food, though it is occasionally given to the other domestic animals. When given to horses, peas are bruised, and mixed with oats, or other farinaceous matters. When ground into meal they are given with good effect to calves and swine, in which case it may be given in the form of a thick gruel. Mixed with the flour of wheat, it may be made into bread, without impairing in any great degree the quality of the former. When used alone for bread it is coarse and unpalatable, though it is not deficient in nutritive properties.

A common application of the produce of the pea is for soups, puddings, and other articles of domestic economy; and an important distinction is made between the different kinds of peas, derived from the difficulty or facility of boiling them. This arises not so much from any difference in the kinds of pease, but from being cultivated on different kinds of soils; those which fall in boiling are termed boilers, and the hard ones owe their property to being cultivated on strong aluminous or calcareous soils; this family having a great tendency to absorb mineral ingredients from the soil. To counteract this, it is only necessary to throw a little of the subcarbonate of soda into the water when boiling.

Pea-straw is much esteemed for fodder, so much, indeed, that cattle are said to thrive on it nearly as well as on hay. Working horses may be kept on it a great part of the season; and it is also much relished by sheep.

In the saving of any particular sort of peas for seed, they should be carefully looked over while in flower, in order to draw out such plants as are not of the right kind; as there will always be, in every sort, some plants which, if left to mix with the others, will cause degeneration. As many rows as may be thought sufficient to furnish the desired quantity of seed should be then marked out, and preserved apart from the rest of the field.

The diseases of the pea are few, and are chiefly the worm in the pod, and the fly on the flower. It is subject occasionally to mildew. None of these, however, are very common, and their prevention and cure are equally beyond the reach of the cultivator.

III.—THE VETCH OR TARE.

The vetch, or tare, is a valuable plant in modern husbandry. It is of hardy growth, and, when grown upon rich land, will return a large supply of green fodder, for the consumption of horses or fattening of cattle. It belongs to the genus *Vicia*, of which there are several species; but that most generally cultivated is the *Vicia sativa*, the common vetch, or tare.

The vetch is found in a wild state growing by hedges, road sides, and in stony places, when not very dry, as in rubbish heaps about quarries. The wild varieties, however, differ from those generally cultivated, in being of a much dwarfer, and more slender habit of growth, and also having much smoother leaves and stalks.

Of the species already mentioned there are several varieties, although only two are generally distinguished by farmers. These are the spring-tare and the winter-tare, which closely resemble each other in their general appearance; and their seeds also differ so little, that it is difficult to distinguish the one sort from the other. The winter variety is distinguished by being usually of a smaller growth, and its pods being more smooth and cylindrical, containing more seeds, and, in its general habit, it is liker the wild variety. The only reliance, however, as to the difference of the seed, must be placed on the integrity of the seedsman. But it is important to ascertain the variety before sowing, as either of them, sown out of its own proper season, is not found to succeed. Spring-tares, for instance, if sown in the autumn, will frequently perish during the winter, in cases where the winter-tare would escape uninjured.

It has been repeatedly ascertained, that winter-tares, sown for a number of seasons in spring, acquire more of the tender nature peculiar to the spring sort, and gradually lose their distinctive characters, so that the two varieties easily emerge into each other. It is, therefore, essential for cultivators to sow such seed as is not only the produce of the true winter-tare, but of that sown in autumn, when the crop is to be sown at that season of the year.

The soil for the tare should belong to the heavier class, as clay, or clayey loam; but it will succeed well on any rich soil not too dry. When the crop is intended for cutting down in a green state, the soil can scarcely be too rich; but, when the tare is cultivated for its seeds, a soil of an inferior description ought to be chosen, otherwise it becomes so luxuriant, that the produce in seed will be deficient.

The preparation of the soil seldom consists of more than one ploughing for winter tares, and a winter and spring ploughing when the seed is sown in spring. In the latter case, the first ploughing should be given in the autumn, as in the case of the preparation of the land for green crops. When only one ploughing is to be given it is, perhaps, better that it should be deferred until the winter sets in, but a second ploughing, with harrowing, rolling, and weeding, is in every case to be given, when practicable. Good and clean tillage is in fact in no case more indispensable, than in that of the tare, though the contrary would seem to be the general opinion from the manner in which the land is prepared for that crop.

The time of sowing depends on the kind of tare, and the purpose in view. The winter variety is sown in September and October; and the first sowing in spring ought to be as early as the season will permit. If the crop is to be cut green throughout the summer and autumn, which is the most advantageous mode of consuming it, successive portions of the ground should be sown at intervals, from the middle of March to the end of May. Summer-tares, when intended for seed, ought to be sown early, otherwise the return will be imperfect; but, for green food, they have, in some instances, been sown so late as the beginning of June; however an earlier seed-time is to be preferred.

Tares are almost universally sown broadcast when intended for green food; but, when cultivated for their seeds, the row-culture may be advantageously adopted; in which case, the management of the crop is, in every respect, similar to that of the pea.

The quantity of seed may be from two and a half to four bushels per acre, according to the time of sowing, and to whether the crop is to be consumed green or allowed to ripen its seeds. In the former case, from three to four bushels will be required, and, in the latter, two and a half will be sufficient.

It is a common and beneficial practice to mix a portion of some of the cereal grasses with the crop, the effect of which is to increase the quantity of fodder; and the stems of the grasses, rising above the foliage of the tares, serve as a support for the latter, and both grow without interrupting each other. When the tare is cultivated for its seeds, it is a good practice to mix a small quantity of beans with the seed before sowing. The quality of the tares is thus found to be improved, as, by clinging to the beans, they are kept from the ground, and enjoy the full benefit of the sun for ripening them in a proper manner ; and they are, in this way, much easier harvested than when sown by themselves. The mixture of seeds which is produced is no objection to the practice, as, from their great inequality of size, they are easily separated in the winnowing process. When the cereal grasses are employed, wheat or rye is best suited for winter-tares, and, for spring-tares, oats. A bushel of either to the acre will be sufficient.

The after-culture given to tares consists merely in pulling out the larger weeds, unless they are in rows, in which case, the horse and hand hoe are to be used. The roller is also employed to prepare the surface for the action of the scythe. When the crop is intended for seed, hoeing and weeding should be more carefully executed, and never be neglected.

Tares, when used as green forage, are cut after the pods are formed, but long before the seeds become ripe. They are exceedingly nutritious, and supply a larger quantity of food for a limited period than almost any other forage-crop. When the tares are cut early, a second crop will be produced ; but, in this case, the land may be more profitably occupied by preparing it immediately for turnips.

In the application of tares, they are found to form a nourishing food for cattle. All the animals of the farm are fond of them, and thrive upon them in an eminent degree. Cows give more butter when fed with this plant than with any other food. Horses thrive better upon tares than they do upon clover and rye-grass ; and the same may be said as to the fattening of cattle, which fatten faster upon this article of green food, than upon any other kind of grass or esculent with which we are acquainted. Hogs may also be fattened entirely upon it.

In this country, the tare is cultivated to come in between the cuttings of clover ; but in England, it is often the principal source of feeding from May to November. It is sometimes ready for cutting before the clover comes in. The first spring crop comes in after the first crop of clover is all consumed or made into hay, and the successive spring sowings afford a supply of green food throughout the summer and autumn.

The diseases of this plant are few, and of little consequence. Under favourable circumstances a failure rarely occurs.

XII.—PLANTS CULTIVATED FOR THEIR FIBRES.

The plants included under this denomination, the culture of which may be regarded as remunerating to the farmer, are the flax and the hemp. Neither of these plants, however, have been generally cultivated, at any time, throughout the United Kingdom. In many parts of Britain, the culture of flax is altogether unknown; while in others it is merely cultivated in quantities sufficient to supply the wants of the farmer's family, no portion being ever taken to market. The same may be said of the hemp, so far as regards its cultivation in this country. The culture of these plants is, therefore, confined to certain districts; and the farmers in these districts, from long-continued practice, arrive at a great degree of perfection in that department of rural economy, and derive profits from it far exceeding what are generally obtained.

The culture of these plants cannot be regarded as being on the increase in these countries. The cultivation of flax in this country has engaged a considerable portion of the attention of the legislature as well as of the farmer, and more laws have been framed relating to it than to any other branch of husbandry. The stimulus of liberal premiums has also not been wanting, and, notwithstanding all this encouragement, its culture is obviously on the decrease; and, what is not a little singular, the cultivation of this plant has decreased in Britain almost in direct proportion as improvements in agriculture have advanced. In districts where manual labour is but little used in the cultivation of the farm, flax cannot be grown with advantage, as a great number of hands is employed in every process connected with it; and, from the great care and attention which are necessary in the performance of every operation, both as regards the time at which it must be performed, and the mode of doing it, flax culture is regarded as unprofitable when farming is conducted on an extensive scale. Another circumstance which has greatly contributed to turn the attention of the agricultural interest from the culture of these plants, is the fact, that the required supply can be obtained from other countries, where the comparative expense of labour is less than in this country. The cultivation of flax will, however, probably continue to engage a portion of the attention of the Irish farmer, and, in particular, of the cottager; in the case of which, the number of hands is large in proportion to the extent of land which is occupied, and more time can, accordingly, be devoted to the culture and management of the plant.

The same remarks are applicable to hemp. Although but little cultivated, it is also suited to our climate, and a large extent of our soil, and, therefore, might be cultivated, in many cases, with advantage. We are, however, still less dependent on the home supply of this plant than on that of flax; and it is inferior to the latter in this respect, that it affords much less employment to the farmer's family in its manufacture.

As these plants are generally cultivated and managed, they make no return of manure towards restoring to the soil that nutriment which they abstracted from it, and, therefore, must be considered as exhausters of the farm. But, under a different system of management, they might be considered as restorative plants, as their seeds contain a large portion of oleaginous and farinaceous matter, supplying rich and nutritious food for the various animals of the farm. This system is rarely adopted in this country, although it is attended with little difficulty. The mode of sowing the seed, and its application, will be afterwards explained.

I.—FLAX.

Flax belongs to the genus *Linum*, of which there are several species; the most important, and the only one forming the subject of cultivation is—

Linum usitatissimum—Common flax.

This is an annual plant, growing with a slender upright stem, branched near the top. It has been cultivated from a very early period in this country, to which it is indigenous, and the fibres have been applied to the making of cloth from time immemorial. The cultivated varieties are few, being produced merely by a difference of soil and climate, and they are chiefly distinguished by the names of the countries from which the seed is imported.

The soils best suited to the growth of flax, are those which contain a large proportion of vegetable matter in their composition. Strong clays do not answer well, nor soils of a gravelly or dry sandy nature. The quality of the soil with regard to fertility is also deserving of attention, as well as its texture. If it be too much enriched by the application of manures, the flax will grow too luxuriantly, and produce a coarse fibre; and if it be deficient in fertility, the produce will be scanty and unremunerative. Soils of the alluvial formation are peculiarly adapted to the culture of flax, and it is on these that the most valuable crops are produced. As an instance of the perfect adaptation of this species of soil to the habits of the plant, that of Holland may be mentioned, which is almost exclusively of the alluvial formation; and the produce of that country has, accordingly, been long celebrated. Good crops of flax may also be raised on land where the upper stratum is black mossy earth, or what farmers call *grey land*, and where the lower part of the soil is clay, resting on a retentive subsoil. Crops of flax, of considerable value, have often been reaped from land of that quality, on which the produce of oats was inferior.

Flax may be cultivated at a considerable elevation above the level of the sea, provided the soil and other circumstances be favourable. But it should never be sown on ground that is liable to be flooded, nor in small enclosures that are surrounded with plantations or high hedges, as these intercept the free circulation of air, and induce mildews.

The proper place for flax, in the rotation of cropping, is soon after the land has been broken up from grass. It is occasionally the first crop after grass or clover lea; but it more frequently succeeds oats after lea, and this may be regarded as the proper place of flax in the course, as the land will then be in a due state of fertility for the production of a good crop, and the flax is succeeded by a green crop.

In the preparation of the soil for flax, it is of importance that it should be reduced to a fine tilth, and cleared of weeds. These are more easily effected in the case of grass land, than when the previous crop has been oats.

The preparation of the land for flax varies according to the crop to which it succeeds. When the previous crop has been grass, a single ploughing only is given, which is to take place early in winter; when the period of sowing arrives, the land is to be well harrowed to prepare it for the seed.

When flax succeeds a corn crop, the land is also ploughed early, the like care being taken to expose it to the effects of frost, without which great labour is required in rendering the soil fine enough for the reception of the seeds. Two ploughings are generally required in the spring, after which all root-weeds are to be picked up and removed from the land, as if it were intended for a green crop. Frequent harrowings and rollings may be necessary for this purpose.

In the culture of flax, the broadcast system is universally adopted. It might be cultivated in drills, like the cereal grasses; but, in the culture of these plants it has been seen that the row method is not likely to come into general use, and in the culture of flax it is much less applicable. The design, in the former case, is to produce a large quantity of seeds, whereas, in the case of flax, the object is to produce long stems without branches. More seed is produced when the stems branch towards the top; but it must be recollected that the production of seed is, in this country at least, only a secondary consideration, the chief object in growing the plant being for its fibres; and, when the stem is branched, the continuity of the fibre is interrupted, and more refuse is produced in the manufacture of the crop.

The mode of sowing flax is the same as in the case of the cereal grasses already described. In all cases, however, the land is to be prepared by previous harrowing, repeated until perfect pulverization is produced. Any loose stones which may appear on the surface after this operation are to be removed; and after sowing, a double turn of the harrows is given to cover the seeds. In most cases it is advantageous that the whole should be rolled, and in damp situations, water-furrowed.

When flax succeeds any of the green crops, the grass-seeds and clover-seeds are sown at the same time as the crop. In this case the preparation of the land is easy. When the other seeds are sown at the same time as the flax, they are harrowed in with the flax-seed. They should, however, be sown rather at a later period, say when the flax is weeded, and the weeders going over the ground will effectually cover them in. If these seeds are sown on the same day with the flax, they should not be mixed with it previous to sowing, as the smallness and weight of the flax-seed would make it sink to the bottom of the sowing-sheet or seed-box, and the sower would sometimes find his hand filled with the one seed more than the other. Flax might, at first sight, seem a very suitable crop for cultivating in conjunction with herbage plants, from the comparatively perfect preparation given to the soil, and the short period which the flax crop is on the ground; and yet such is not found to be the case, as the plants of flax stand too closely together to admit of the free growth of the clovers and grasses between them, and these plants are accordingly found to succeed better when sown with a corn crop.

The period of sowing is in the month of April, chiefly towards the latter end of the month. In this country, where the culture of flax is better understood than that of almost any other plant, the time of sowing varies greatly in different districts. In some it is sown in March, and in others the process is performed in the month of May. From the middle towards the end of the month of April may, however, be regarded as the proper seed-time.

The quantity of seed sown will depend, in some measure, on the object in view in cultivating the plant. When the quality of the fibre is regarded rather than the quantity, thick sowing is advisable; but if it be intended to save the seed of the crop for the purpose of reproduction, it should be sown thin, in order that the plants may have room to throw out lateral shoots, and to have free access of air in the blossoming and filling seasons. Thick-sown flax runs up in height, and produces fibres of a good quality; if sown thin, it does not rise so high, but spreads more, and puts forth many side branches which produce abundance of seed; and such seed is much better filled, plumper, and heavier, than the seed produced from the thick-sown flax. Three bushels of seed may be regarded as the proper quantity; but if fine fibre must be produced, an additional quarter of a bushel may be added; and, on the other hand, when the seed is regarded, two bushels or two and a half may be sufficient to the acre.

The greater part of the flax-seed sown in this country is imported. That brought from Holland is in highest estimation, as it not only ripens sooner than the others, but also produces larger crops, and flax of that quality which best suits the manufactures of the country. A considerable portion is also obtained from Russia and America. Frequent changing of the seed is necessary, the plants being found to degenerate when produced from seed repeatedly sown on the same land. The superiority of foreign seed over that which might be produced in this country, arises chiefly from the greater attention which is paid to the ripening and preparing of it; and were the same attention paid to the production of seed of home growth, it cannot be doubted that it would be of as good quality as that which is imported. A change of seed would, however, still be necessary, and importations must take place; but once in two or three years would be often enough to sow foreign seed.

The propriety of sowing seed produced at home, even in preference to that imported, would appear from the practice of the Dutch, who are not surpassed in the cultivation of flax by any other people in the world. They are, however, aware of the necessity of a change of seed, and, although they raise and export much, they also bring much of what they sow from Riga; and their management, in this respect, is worthy of attention. Riga seed, when sown in Holland, is generally found to grow coarse, and yield a bulky crop the first year. The seed produced from this is always sown a second year, and the seed it then yields is not sold by the Dutch, as they always find it to produce the best and finest flax. The seed of the second year's growth is called *Riga-kind* (or Riga offspring) by the Dutch boors, which they hold to be of double value to the seed of the third crop, which they export. In order to serve themselves with seed of the best quality, many of the growers of flax in Holland sow a small quantity of Riga seed every year, to secure Riga-kind, or seed of the second year's growth, for their own use; and none of them sow the seed produced from the third crop, but send it to the foreign markets.*

It would then appear that our growers of flax might easily raise at home a considerable portion of the seed they require, and that, perhaps, of superior quality, instead of using so much of that from foreign countries, some of which is the refuse of their markets. The sagacious Dutchmen have found out a species of seed, for their own use, that is of twice the value to them of the seed they send over to us; and if our farmers were at due pains they might either raise the best seed for themselves, or find out how the seed of one crop was in

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* Quarterly Journal of Agriculture, vol. iv.

Holland of double the value of that of the next crop from the same seed, and raise what was found most valuable. Our soil and climate are known to be as favourable as any other for the growth of flax, and the same care and attention only are wanting to secure seed of as good quality as that raised in any other country.

The quality of flax-seed is easily ascertained, and it is of great importance that every farmer should know the marks of good seed, to distinguish it from that which is of inferior quality. Flax-seed that is fresh and proper for sowing should be smooth, slippery, bright, plump, and so heavy as to sink in water. It should taste sweet, and, on being broken, it should appear of a light yellowish green colour, and oily. Seeds which do not present these characters are unfit for sowing.

The after-culture of the flax crop is chiefly confined to weeding; but sometimes it commences with rolling the surface, which is a very proper operation when the soil is very dry, the season advanced, or the earth very porous. By this process the soil is placed firmly to the roots of the plants, and the drought is excluded. Weeding commences when the plants are about three or four inches in height. It is generally performed by young persons or females, who advance in a kneeling posture, the better to enable them to pluck up every weed growing amongst the plants. If the land has been properly prepared before sowing the seed, it will not require more than one thorough weeding. The greatest care and attention are, however, necessary in performing this process, as the weeds cannot be separated from the plants at any future period without difficulty, and when allowed to remain, they greatly injure the quality of the fibre.

The state of ripeness at which the crop is to be taken up depends on the object in view in its cultivation. Should the object be to produce seeds, either for sowing again or for consumption by live-stock, then a degree of ripeness is essential, which it is not desirable should be attained when the quality of the fibre is the chief desideratum. In the latter case, it is advisable that the flax should be pulled in a somewhat green state. In the former case, the state of ripeness is denoted by the seed vessels becoming hardened, the stems assuming a yellow hue, and the leaves beginning to fall. When the seeds are not intended for sowing again, though intended to be saved for consumption on the farm, the best period of pulling is shortly after the plants have attained maturity with respect to the formation, but not to the full ripening of the seeds. In this case, the operation has not been delayed so long as materially to affect the quality of the fibre, and a large return of seed will be obtained.

Flax should never be pulled when it is in the least degree damp, as in that case the bark or fibre is much injured by being rubbed and handled in pulling. If any part of the crop happens to fall down and lodge before it is ripe, it should be immediately pulled, and kept by itself, as it cannot have strength to stand the operations of bruising and scutching along with the other flax. Every part of the field should be pulled as it ripens; and none should be pulled until it is completely ripe. If the part on the crowns of the ridges shall ripen before that towards the furrows, the ripe flax should be taken up, and the green allowed to stand till it becomes ripe.

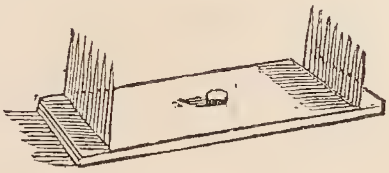
The greatest care should be taken, when pulling, to sort the flax. so as to keep that of every kind and quality by itself—the long and coarse in bunches by themselves—the fine, the short, and every different kind, separate from each other; so that they may be managed and dressed as they severally require, and put to the uses for which they are best adapted. Attention to the sorting of flax according to its quality is too much neglected in this country; but it is particularly attended to in Holland, and hence the superiority of the flax imported from that country, so far as regards uniformity of quality.

When the crop is ready for pulling, the plants are pulled up and bound into sheaves or bunches, of nearly the same size as sheaves of corn. The bands are sometimes formed of the flax itself, and sometimes of single lengths of wheaten straw; but the more usual practice is to use rushes, in districts where they can be obtained, which have been previously bruised and dried for the purpose. They are formed into bands by uniting two lengths of the rushes, and the persons pulling fasten a number of these round their waists for convenience. After the bunches are bound they are set up into stooks like corn, but without the hood sheaves, or they are at once removed to where the process of rippling is carried on.

When the seed of the flax is intended for reproduction, the stems are laid in handfuls crossing each other, as they are pulled, and in this state the crop is allowed to remain for a few days to wither. This is done in order to fully mature the seeds.

In the process of rippling, which is the next operation, a large cloth should be spread upon a convenient spot of ground, with the ripple placed in the centre of it. The rippling machine is an instrument like a comb, with iron teeth, fixed upon a plank. The flax is separated into handfuls by young persons, and handed to the ripplers, who draw it once or twice through the teeth of the machine, and thus the capsules or seed-vessels are separated. There may be two sets of teeth in the machine, which is placed on an elevated stand for convenience to the workmen; and such a number of these must be employed as is sufficient to separate the seeds from the flax in a proper time. The flax is afterwards bound up into bunches, when it is ready to be carried to the watering place, and the capsules containing the seeds are collected and carried from the field. The process of rippling is the same whatever may be the design in saving the seeds. It is objected to by some, on the ground that the quality of the fibre is injured by the operation; but so far is this from being the case, that the seed is sometimes rippled off, even when there is no intention of saving it, as the flax becomes thereby more equally watered.

Fig. 74.



The capsules or pods, thus obtained, should be spread in the sun to dry; and those seeds which separate from the pods without bruising, being the best and ripest, may be separated from the remainder and set apart for sowing. The capsules are then broken, either by treading or thrashing, in order to get out the remaining seeds, which should be then carefully winnowed and cleaned. When the seed is put into the store it must be well ventilated, and winnowed occasionally, if it feels moist, to prevent it from heating. The drying of the capsules thoroughly is the most difficult part of the process of saving flax-seed; and, if this be not effectually accomplished, an active fermentation will speedily take place.

The practice of saving flax-seed on the Continent, and, in some instances, in this country, is somewhat different from that just described. Instead of separating the capsules from the flax, immediately after pulling, they are allowed to remain on it until the following spring, being thoroughly dried and win on the plants. The bunches are set up to dry in the field in stooks, like grain crops, for at least two weeks, and either put into barns, or stacked for a time, till the seed is well dried on the flax. It is afterwards separated by thrashing or rippling, always taking care not to rub or hurt the flax when removing the seed. When once the flax and seed have been dried together, the flax is not so easily hurt as when it is green and damp; still it should not be rubbed or handled roughly, as the fibre is easily injured by handling.

Some have objected to the method of drying the flax before it is steeped, affirming that it makes the fibre coarse and harsh, more difficult to be watered, and longer kept from the market. But it would appear, that the first two of these objections are obviated by the superior quality of the Continental flax, as compared with that produced in this country, though the invariable practice of the flax-growing districts there, is to dry and store the flax for some time previous to its being put in the steep. Unless, however, the seeds are to be sown, they may be taken off the flax before it is removed from the field, so as to get it steeped before the winter sets in.

The next process in the management of the flax is the separation of the fibres from the stem. This is done by steeping the flax in water, by which the softer part partially undergoes the putrefactive fermentation. The water most proper for steeping flax should be clear, soft, and in standing pools. Compared with running water, that which is stagnant occasions the flax to have a better colour, to be sooner ready for the grass, and even to be of superior quality in every respect. The bunches of flax should be built in the pool in nearly an upright position, the root-ends being uppermost. They are kept under the water by stones, or heavy substances of any kind; they should not, however, be compressed to the bottom, but merely so loaded, that they shall be kept below water. Waters impregnated with any mineral substance should not be employed.

This is the most critical, and one of the most important operations in preparing the crop for the market; and the value of the fibre, and the profit it yields, depend more upon the right mode of watering it than upon any thing else which the grower of flax has to perform. The putrefactive process must not proceed too far, otherwise the fibrous, as well as the more mucilaginous part of the bark, may be affected. The length of time which is necessary to effect this depends on various circumstances, as the state of ripeness in which the crop was pulled, the quality of the water and the temperature of the weather. When the flax is properly watered, it will be observed to sink in the pool, and the fibres will separate freely from the stalk. In warm weather, eight or ten days will sometimes be sufficient, and, in other cases, ten or twelve, or even longer, may be required. To avoid mistakes, however, on that important point, a few stalks should be drawn from the heart of some of the sheaves at different parts of the pond, and carefully examined; and this, it is to be observed, should be done daily, after the fifth or sixth day, until the flax is sufficiently watered. Some of the stalks may be broken at different distances along the stem, and, if the heart of the stem can be easily separated from, and drawn out of the fibres, it is time to remove the flax; but, if the fibres still adhere to the stem, so as to be separated with difficulty, it must be continued in the water for some time longer. Great care on this point is necessary, as a single day, or even a few hours too long in the water, may render the fibre soft, weak, and brittle; and, if it is not properly watered, the fibre is coarse, and cannot be easily separated from the stem. But it is better that the flax should not be sufficiently watered, than that it should be continued too long in the water, as, in the first, a little more time in the succeeding process may rectify the evil, but an excess of watering admits of no remedy.

When, after minute examination, it has been ascertained, that the flax is sufficiently watered, it is taken out of the pool, and after remaining in heaps for a short time to allow the water to drain off, it is taken to a grass field, and spread thinly over it in rows. The intention of performing this operation is to rectify any defect in the watering process, and carry on the putrefactive fermentation to that point when the fibre will separate from the reed, or woody part of the stem, with the greatest ease: and also to expose the flax to rains, for the purpose of washing off impurities contracted in the water. Old grass-land, where the herbage does not grow to any great height, is the best for the purpose; for, when the flax is covered by the grass, or weeds, it is frequently injured, so as to be of little value.

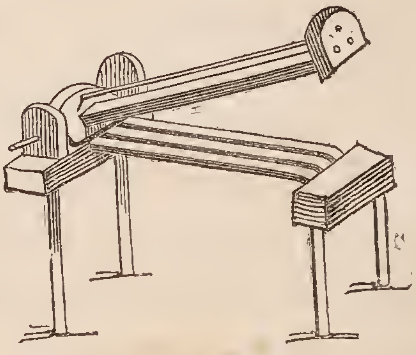
The time allowed for lying on the grass is regulated by the state of the flax, and seldom exceeds eight or ten days. During this time it is repeatedly examined, and, when it is found that the reed has become brittle, so that, on being broken and rubbed between the hands, it easily and freely separates from the fibres, it is taken up, a dry day being chosen for the purpose, and again bound into sheaves or bunches. These are much larger than those made before the watering process, and, if the flax is sufficiently dry, the large size of the bunches is attended with no other inconvenience than the increased difficulty of loading them on the carts. The bunches of flax are usually allowed to remain some time in the field, that they may become thoroughly dried; after which, they are sent directly to the mill, or carried home and stored in some convenient place until required for use.

Whether the flax has been taken to the water soon after being pulled, or stored previous to watering, in imitation of the Dutch system of saving the seed, the process of watering and spreading on the grass is the same, and the same attention is necessary, in both cases, to secure the proper performance of them.

This completes the management of the crop, so far as the cultivator is concerned, the remaining operations more properly belonging to the manufacturer, by whom they are, in general, much better performed. But sometimes the manufacture proceeds on the farm itself, and more particularly in the case of the cottager and small farmer. In this case the different operations may be either performed by machinery or by manual labour.

The first process in the manufacture of the flax is breaking the woody parts of the stem, for the purpose of separating the reed from the fibre. This is usually done by an instrument called *a break*, which consists of two wooden frames, attached to each other by a hinge. The cross-bars of the frames are so placed, that two of them shall not be opposite to each other, and the number of cross-bars in the upper frame is usually one less than that in the lower one. The upper, or moving half, being raised, and a handful of dry flax laid right across the bars of the lower frame, the upper one is forced down on the flax, which is thus broken and crushed, and the operation repeated, and the flax turned over and over; the reed or woody part of the stems is thus

Fig. 75.



broken, so as to be well prepared for being scutched with effect. The handful is then twisted and laid aside, and another taken up to undergo a similar operation.

Another mode of bruising the flax remains to be described, and the plan is more adopted by the manufacturer than by the farmer; but it is also occasionally employed by the latter. A large stone is procured, the same as that employed for grinding grain into meal or flour, in the centre of which the end of a long pole is securely fastened. The other end of the pole is connected with the top of an upright post, firmly placed in the ground, in such a manner, that the stone can revolve freely, the pole in the horizontal position being considered as an axis. This axis projects slightly through the stone, and a hook fastened to it by which it is turned round. When the stone is set in motion, its path will be obviously a circle, and on this path the flax is spread, and moved backwards and forwards from time to time, so that every part of it may be bruised. The stone is rolled round by a horse, which walks outside the circular ring of flax.

It is sometimes necessary that the flax should be dried by artificial means previous to its undergoing this process, to facilitate the separation of the fibre from the woody part of the stem. This is, however, only necessary when the flax has not been thoroughly dried after being taken off the grass, or when it has been stored in a damp place; and an excess of drying is to be carefully guarded against, as it is injurious to the quality of the fibre.

Scutching may also be performed either by machinery or by manual labour. The latter is well known in the different districts of Ireland in which flax is cultivated, as it is very generally employed. It is very evidently inadmissible when flax is cultivated to any considerable extent, from the difficulty of procuring a sufficient number of hands to perform the work. The operation of scutching is, therefore, often performed by machinery.

The flax is now ready for market, and, when the crop is disposed of in this way, no other preparation is given. To fit it for spinning, however, it goes to another class of persons, termed *hecklers*, by whom the refuse is further separated from the fibre. The refuse after this operation is tow, which is also manufactured into thread of a coarser description, suited for various purposes.

The produce of the flax in fibre varies greatly from the difficulty in performing the several operations in a proper manner. After being scutched, when it is ready for market, the average produce may be calculated at from four to six cwt. to the acre, although so much as eight cwt. to the acre is sometimes produced.

Besides the produce of the plant in fibre, that of its seed is of considerable importance. The quantity of seed produced on the acre varies as greatly as that of the fibre. It may be assumed to be from six to ten, or twelve bushels.

The seed, we have already seen, is usually separated into sorts, according to their quality; the first being reserved for sowing, and the remainder for bruising for oil, or being consumed by cattle. It must, however, be observed, that no part is to be employed as seed, unless it has been thoroughly ripened, and prepared in the best manner, otherwise the succeeding crop will be inferior. For either of the other purposes, it will be found highly valuable, and will contribute, in a material degree, to the value of the crop.

Flax-seed is in demand in this country for the oil manufacture, and it may be disposed of in this manner. The oil is obtained from it by expression, and is that which is in common use with painters. The refuse of the oil manufacture, or that portion of the seed which remains after the oil is expressed, is known by the name of oil-cake, and is largely used in the fattening of cattle.

But the best method of disposing of the seed is that of consuming it on the farm; and, in this case, flax cannot be considered as an exhausting crop, although, in every other, it is decidedly so. It is highly nutritive in every form, and may be given to every species of animals with good effect. It is given in the form of a jelly, mixed with various other matters. Given to calves, it forms an excellent substitute for milk, and is valuable for these animals. To horses and cattle it may be given, mixed with bruised oats, bran, or cut hay and straw, in which state it is highly relished, and its nutritive properties will soon be manifested by the superior condition of the stock to which it is given. When intended for cattle, the chaff, or refuse, need not be separated from the seeds, but all boiled together, as it also contains a large portion of nutrient matter.

The seed of flax is always taken off on the Continent, and preserved, either to be sown, or to be bruised for oil, or given to cattle;

and it evidently betrays great want of industry not to do so. It may not always answer in this country, nor can the whole of it be used for seed; but it is too valuable, for the oil it contains, and as food for cattle, to allow any part of it to be lost. We have seen that it is of great value as food for cattle, and may be used in this way with advantage. From the extraordinary labour performed by cart and road horses, and the high feeding they require, they are often affected with inflammatory diseases. But if the proprietors of horses could be induced to give each of them a single handful of flax-seed daily, or occasionally, boiled with beans or other food, it would operate as an antidote, or a cure, to those inflammations by which so many animals are lost. Instead of this, the Irish farmer, and, we might also add, the British farmer, too often throw away their flax-seed in the water in which the plant is steeped, where it serves to poison fishes, and to render the water and air unwholesome, as well as to injure the flax.

It has already been observed, that flax is a hazardous crop, and, on this account, its cultivation cannot be regarded as being on the increase. In the market-price there is also great variation, being sometimes very high, while, in others, it is so low, that it cannot be regarded as remunerating. These circumstances have tended to diminish the extent of land appropriated to its cultivation. Saving the seed is little attended to, from a mistaken notion, that the quality of the fibre would be thereby greatly injured; but were this the case, how can it be supposed that the Dutch can produce flax of a superior quality to ours, at the same time that they furnish us with the greater part of the seed which we import? Were attention directed to this subject, the culture of flax would be better deserving of encouragement than it is at present, as it would then be greatly more renumerating to the cultivator.

II.—HEMP.

The hemp, *Cannabis sativa*, is supposed to be of eastern origin, being too tender to be naturalized in Europe. It belongs, however, to the natural order *Urticeæ*, or the nettle tribe, which is indigenous to this country, and is diffused over the world.

The hemp is one of those few agricultural plants which are diœcious, that is, producing male and female flowers on different plants, a circumstance which has some influence on its culture and management. It grows to a great height on good soils, sometimes to the height of six or seven feet in this country. But, in the Bolognese territory, it is said to rise to the height of twelve and fifteen feet, the fibre being, at the same time, of remarkable beauty.

The culture of the hemp is but little practised by the Irish farmer, indeed scarcely known; and in Britain, it is chiefly confined to Lincolnshire, Cambridgeshire, and Suffolk. Its culture, management, and uses, are nearly the same as those of flax. When grown for seed, it is a very exhausting crop, but, when pulled green, it is considered a cleaner of the ground, and it is said to have the property of preserving from insects any crop that it may surround.

The soils most suitable for hemp are those strong, deep loams which contain a large proportion of vegetable matter. It requires a richer soil than flax, for it is always strong in the fibre, in proportion to the richness of the ground on which it has been produced. On peaty soils it has been found to succeed as well as on any others.

The preparation of the land, and the place in the rotation, are the same as for flax. It is a more cleaning crop than flax, and may, therefore, with greater propriety, succeed a corn-crop on land in a foul state. As to its effects on the land, they are the same as in the case of flax, depending entirely on the object in view in cultivating the crop.

The hemp being easily injured by the spring frosts must be sown at a later period than flax. The beginning of May is the usual seed-time.

The mode of sowing hemp, like flax, is broadcast. It might be cultivated in rows to admit of tillage during the growth of the plants, but this renders the hemp coarse, and the rapid growth of the crop renders any after tillage unnecessary when the land has been properly prepared. The quantity of seed is usually from two to three bushels to the acre, and care must be taken that it is fresh, to insure its growth, which is denoted by its heaviness and brightness of colour.

As the season advances, the hemp grows with great rapidity, and like the flax-crop, is taken up by pulling. In taking up the hemp-crop, two methods are in use, according to the object in view. When the crop is grown entirely for the fibre, it is pulled when in flower, and no distinction made between male and female plants. But, as it is most commonly grown both with a view to fibre and seed, the usual practice is to pull the male plants as soon as the setting of the seed in the females shows that they have effected their purpose. As the female plants require from four to five weeks to ripen their seeds, the males are thus pulled so long before them. Thus the circumstance of the male and female flowers, being on different plants, gives rise to a peculiarity in the method of treating the hemp, which exists in the case of no other of our cultivated plants.

The male plants are distinguished from the female by the production of numerous flowers, and being also in general more delicate. The stem of the male plant is divided into numerous branches, which terminate in slender spikes, the flowers hanging, when they expand, in clusters of a purple colour, pendent from the leaves; whilst that of the female terminates in tufts, and leaves of a considerable size, among which we find the seed, which is borne along the stem.

As soon as the male plants have performed the important function of impregnation, which is denoted by the growth of the seeds upon the female plants, they are to be taken up, the latter being allowed to remain. For this purpose, the pullers walk in the furrows, and reach across the half of each of the adjoining ridges, observing carefully to avoid injuring the remaining plants. When the female plants have matured their seeds, they are also pulled; and after being bound up into sheaves, they are stooked in the same manner as grain. When thoroughly dried, the seeds are separated from the stalks by a slight thrashing; or it is effected in some cases by a chopping knife, which cuts off the seed pods, and the seeds are again separated from these by a subsequent operation.

The operations of watering and spreading the hemp on the grass, closely resemble the same operations with flax. The male plants undergo these operations before the female plants; but frequently the latter are not watered until the succeeding season, being stacked and prepared the following spring and summer, as is sometimes the case with flax, when saving the seed is an important consideration.

A much shorter time is necessary for hemp to remain in the water than for flax. As in the case of that plant, the precise time is denoted by the softening of the outer covering of the stem, so that it will come readily off. From four to six days are usually sufficient, especially if the weather be warm. During the period while it remains on the grass, it is sometimes turned over, and afterwards allowed to remain some time before being lifted. The operation of bruising does not differ from that in the case of flax already described.

After the operation of bruising it is ready for the market. The term shorts is technically applied to the portion which breaks off in the process of bruising, and it is usually considered to be nearly of half the value of the hemp.

The produce of the hemp, in this state, varies from four to six cwt. to the acre. The produce in seed is usually ten or twelve bushels. It often, however, greatly exceeds this amount.

The uses of the hemp are well known. It is extensively used for the making of canvass and cordage of all descriptions, for which purpose the great elasticity of its fibres eminently suits it. It is also largely employed in the manufacture of numerous fabrics used in domestic economy, as towels, coarse table cloths, and other similar articles. The fine sorts of hemp are, indeed, manufactured into a description of cloths, which is prized beyond the finest linens; as, independent of their greater durability, they possess the singular property of their colour improving by wearing, while that of linen declines.

XIII.—CULTURE OF FORAGE AND HERBAGE PLANTS.

The culture of forage and herbage plants is comparatively a modern improvement. They were, however, known to the Greeks and Romans as profitable objects of cultivation, and were also cultivated from a very early period in the Low Countries; but they do not appear to have attracted much notice in Britain till the beginning of the sixteenth century, when our frequent intercourse with Holland led to the introduction of some of our best field plants. At present the cultivated forage and herbage plants enter largely into the succession of crops, on all soils, and in every productive course of management. Before their cultivation was introduced, it was necessary, when the land became exhausted by grain crops, to leave it a state of comparative sterility for a number of years, before it again became valuable as pasture, or fit for the production of corn; but, at present, these plants are not only indispensable in the cultivation of white and green crops alternately, upon rich soils, but are the foundation of convertible husbandry upon the land that is not sufficiently fertile to bear constant cropping, and which, therefore, requires two or more years' pasturage at intervals.*

The variety of forage and herbage plants with which our fields are clothed, whether produced by nature or by art, furnishes subsistence to a number of animals subservient to the human race. By a judicious selection of the more valuable species the farmer is enabled to maintain an increased number of live-stock, at the same time that the condition of his land is improved, and prepared for the production of other crops. The importance of attending to the culture of these plants is not felt to the extent that could be wished in this country; but it is to be hoped that our farmers will not continue to neglect such a profitable branch of rural economy as the culture of this class of plants affords, seeing that the advantages to be derived from it are so well established.

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* Encyclopædia of Agriculture.

The characteristic points of culture, in the case of these plants, are broadcast sowing, soiling, hay-making, and pasturage. No return is obtained from them the year they are sown, and, for this reason, they are usually sown with a corn crop. Their culture and management vary according to the object in view in their production, and they are usually mixed together in definite proportions; but, before entering on these particulars, it will be necessary to give some account of each species. The plants cultivated, or capable of being advantageously cultivated in this country for forage and herbage, may be arranged in the following order:—

1. Leguminous plants, or those having their seeds in legumes, or pods, and belonging to the natural order *Leguminosæ.*
2. Gramineous plants, comprehending the grasses, and belonging to the natural order *Gramineæ.*
3. Cruciferous and other forage and herbage plants not included in the foregoing divisions, and belonging to the natural orders *Cruciferæ, Boragineæ,* &c.

The plants belonging to the first of these divisions are occasionally used both for forage and herbage, but chiefly as forage; those of the second are also used for both purposes, but chiefly for herbage; and those of the third are almost exclusively cultivated for forage alone.

I.—LEGUMINOUS PLANTS.

The cultivated leguminous plants are chiefly valued on account of the large quantity of nutritious forage they afford, and some of them yield several crops in the season, when cultivated under favourable circumstances. Those deserving of attention are—

1. The Tare and other species of Vetch.
2. Lucern.
3. Sainfoin.
4. Clovers, Vetchlings, Melilots, &c.

The Tare, *Vicia sativa,* is in general cultivation as a forage plant, being both nutritious and productive; but it is also, in many cases, cultivated for its seeds, which are used chiefly for reproduction; but in some instances they are employed as food for poultry and other animals, and, on this account, its cultivation has been treated of in connnexion with the leguminous plants cultivated for their seeds.

Besides the common tare, there are several other species of the genus *Vicia* which might be cultivated for forage.

The Biennial Vetch, *Vicia biennis*, is a native of Siberia. It has been much recommended for cultivation, as it not only grows to a great height, and yields a large bulk of fodder, but it remains green throughout the winter, and comes early in spring. Although long introduced, its culture has not been much attended to in this country; but it is grown in some parts of France, and frequently in Germany, on light soils. Those who cultivate it in the latter country find it advisable to sow it in mixture with one or other of the melilots, as from its tall and slender habit of growth, unless supported, it is apt to become lodged, and much damaged in damp weather.

The Tufted Vetch, *Vicia cracca*, is of every luxuriant growth, and flowers at a late period of the season. It yields a considerable bulk of fodder, which is greedily eaten by cattle, and is considered to be a more nutritious and healthy article of food than the common tare. Were the culture of this plant more generally practised, it might, perhaps, supply a desideratum, namely, the affording of a large quantity of green forage after the pastures have begun to decay in autumn. It succeeds best on a soil of medium texture, but will also grow on such as are of a light sandy nature, or even on strong clays when well drained, and the moisture prevented from stagnating about the roots of the plants during the winter and spring.

The Bush Vetch, *Vicia sepium*, is a perennial plant flowering at an early period of the season, and producing a large amount of forage. It is found about hedges and shady places, and generally on superior and rather dry soils. From its rather dwarfish and close bushy habit of growth, it does not require the aid of other plants for its support to the same extent as the other species of the genus to which it belongs. It possesses the property of dispersing the seeds as soon as they are ripe, which makes it difficult to procure them in quantity. From the result of the various trials which have been made with this plant, it appears to be deserving of further attention by cultivation, as happens in the case of other wild plants.

The Villous or Hairy Vetch, *Vicia vilosa*, greatly resembles the tufted vetch, for which, at first sight, it is apt to be mistaken. This resemblance, however, is chiefly in the flowers and foliage ; and an essential difference between them is, that this species has an annual root, and the tufted vetch a perennial one. The whole of the plant is also more villous or hairy, of a taller and more branching habit of growth, and produces a greater number of pods. It is of rather slender growth, and relying, like most of the other species, on whatever stronger plants may be growing near it for support. It possesses the same advantage as the tufted vetch, that of containing a comparatively smaller proportion of moisture than the common tare, and being eagerly consumed by horses or cattle either in a green or a dry state. When sown in spring, it comes away rather slowly at first, as compared with a common tare ; but its actual weight, or bulk of produce from a given space of ground, when full grown, may be reckoned nearly double that of the other. Should further experience prove it to be suitable for sowing as a winter vetch, it will add greatly to its value.

Of the important genus *Vicia*, nearly a hundred species have been enumerated by botanists, many of which seem highly deserving of further experiments with a view of ascertaining their economical uses and properties, as many of them are, as yet, in a great measure unknown. The culture of the different species is not materially different from that of the common tare, which has been already described at length.

The lucern, *Medicago sativa*, is a deep-rooting perennial plant, sending up numerous small clover-like shoots, with blue or violet coloured spikes of flowers. It is a native of the South of Europe, and has been cultivated in Spain, Italy, and the South of France, from a very early period. It was introduced into England from France about the middle of the seventeenth century, and is extensively cultivated in Kent, and some of the other southern counties.

The climate for lucern must be warm and dry, and this circumstance has been found unfavourable to its extended cultivation in our variable climate.

The proper soil for lucern is a rich deep loam, though any friable ground of a deep and open nature will answer, provided it be thoroughly drained, and enriched by the application of manures. It will not succeed on clays, nor on soils that are too dry and parching. The under-stratum of the soil is of as much importance as the upper, in the successful cultivation of lucern; for the fertility of the latter can be increased by manures and kept open by culture, and may thus, for a certain time, be rendered productive; but if the subsoil be adhesive, or at all of a wet and clayey nature, the plants which seek for nourishment by striking their roots to a great depth, being stopped in their progress by the closeness or unfavourable nature of the subsoil, cease to vegetate, and finally perish. Thus many farmers who are possessed of fertile loams which grow good crops of corn and clover, though lying upon a cold and impenetrable subsoil, have found their expectations deceived when they have calculated upon the successful cultivation of lucern. The soil must be deep, and of the lighter class, with a free and kindly subsoil; and when these circumstances do not exist, it is better not to attempt the culture of this plant.

The preparation of the soil for lucern consists in deep ploughing and minute pulverization, which is effected either by a previous summer-fallow, or fallow-crop. The most effectual preparation is trenching by the spade, and when the operation is going forward, a liberal application of manure should take place, which can then be incorporated with the soil and buried to a good depth. This plan of preparation is evidently inadmissible when the plant is cultivated on a large scale; but when it is wished merely to possess a small patch of lucern for the convenience of soiling, it is well to have the preparation of the soil as perfect as practicable, and that it be enriched by the application of both organic and calcareous manures, as any expense incurred in this way will be amply repaid by the luxuriance of the succeeding crops.

In the cultivation of lucern, the row system is adopted, and the mode of sowing closely resembles that of sowing turnip and rape seeds on a flat surface, by marking it off in rows after being previously well harrowed. The rows need not be more than sixteen or eighteen inches apart, which gives room for tilling the intervals both by the horse and hand hoe. When lucern is cultivated in small patches by the cottager, in the management of which horse labour is not required, the intervals between the rows need not be more than ten or twelve inches, which admits of the hand-hoe being used.

The period of sowing lucern should be as early as practicable in the spring months, that the plants may have made some progress before the warm weather sets in. It should not, in any case, be delayed longer than the middle of April. The quantity of seeds to the acre, is ten or twelve pounds. The seeds are paler and larger than those of clover.

The mode of treatment in the subsequent stages of the growth of the crop requires nothing more than careful attention to the destruction of weeds, especially root-weeds—both by the harrow and by hand-hoeing. After a liberal use of the harrow, the crop appears as if it were completely destroyed; but the process, instead of being injurious, is essential, and the plants soon recover from the apparent injury thus sustained, and regain their usual appearance.

The lucern will be ready for cutting in the month of August of the first year. In the succeeding spring, the crop is to be again thoroughly hoed, so that the weeds may be destroyed, and the soil pulverized about the roots of the plants. The crop will afterwards be ready for cutting towards the end of May. In this manner, with alternate cuttings and hoeings, it may be cut three or four times in the season. It does not arrive at its full growth until its third year, but after this, it will continue to yield annually a large return of rich and early foliage for ten, or twelve, or even fifteen years. It requires manuring every third or fourth year, and ashes, gypsum, or liquid manure is that commonly applied.

Lucern is sooner ready for cutting than most other forage or herbage plants. When the situation is suited to the habits of the plant, and the season favourable, the first cutting may often take place towards the end of April, at which time it will probably have attained the height of two feet or more. It should be cut immediately before it comes into flower, as it will afterwards push forward its new shoots with greater vigour.

The produce of lucern, comprehending the different cuttings of the season, has been stated at from four to five, and even sometimes eight tons to the acre. For soiling, an acre is sufficient for three or four cows during the season. But, on the supposition that it is only equal in bulk to a crop of red clover, under similar circumstances, and, if continued yearly, for ten or twelve years, at an annual expense of harrowing, and rolling occasionally, and a triennial or quinquennial one of manuring, it will be of sufficient value to induce such farmers as have suitable soils and situations, to lay down a small piece of land under this crop, near their farmeries.

The Sainfoin, *Onobrychis sativa*, is a deep-rooting perennial plant, with branching stems, compound leaves, and showy red flowers. It has long been cultivated in France, and other parts of the Continent, as an agricultural plant, and was introduced into England about the middle of the seventeenth century. It has since been a good deal cultivated in the chalky districts; and its peculiar value is, that it may be grown on soils unfit for being constantly under tillage, and which yield little in grass.

Sainfoin is peculiarly adapted to the lighter class of soils. It grows wonderfully on rocky soils, stretching its roots to a prodigious depth among the crevices of the rocks. On a chalky rock, covered with only a few inches of soil, it will thrive and grow for many years with vigour, where neither corn nor cultivated herbage plants would cover the surface.

The preparation of the soil for sainfoin is similar to that for lucern, and consists in deep and minute pulverization, and the thorough eradication of weeds. The mode of sowing is almost universally broadcast, and the seed is sown with a corn crop in spring, in the same manner as that of the clovers and grasses. In the following season, it may be cut for hay or green forage, although it does not attain its full maturity until the third year.

The corn crop with which sainfoin is usually sown is barley, as both these plants are suited to the same kind of soil. It is better that the barley should be sown thin, in which case it will serve to shade the growing plants of sainfoin, and keep them moist during the summer. It is sown simultaneously with the barley, and the seeds being somewhat large, they are to be covered to a good depth. The roller is used with propriety after the seeds have been covered by the harrows.

The quantity of seed is about four bushels to the acre. A smaller allowance may suffice, but, on such soils as are proper for this plant, it is always necessary to have a full proportion of seed. The best period of sowing is in the month of March.

The application of sainfoin is chiefly for being made into hay. The proper season for cutting is when the plants are in full flower; and the several operations of hay-making are the same as in the case of the other hay plants. Great care is, however, necessary in the process; for its perfection consists in retaining the natural bloom and figure of the flower, and the clear and healthy green of the stems and leaves. It is easily injured by rain, as not only are the richness and fragrance of the hay thus deteriorated, but the porous nature of the stems of the plants renders them difficult to be dried after being thoroughly wetted. In general, it may be reckoned that a greater quantity of hay will be procured from it upon thin calcareous soils than from a first cutting of clover, and it is of superior quality and value.

The usual duration of sainfoin in a profitable state is from eight to ten years. It attains its perfect growth in about three years, and begins to decline about the eighth or tenth on calcareous soils, and much sooner on other soils less suited to its growth. There are instances, however, of fields of sainfoin which have been neglected, in which plants of sainfoin have been found upwards of fifty years after the time of sowing. In general, the great enemies to the duration of the plant are the grasses, which accumulate and form a close turf on the surface, and thus choke it up.

In saving seed from sainfoin, it should remain on the ground until the husks become of a somewhat brownish colour, and the seeds are perfectly plump and firm. They ripen very unequally, arising from the circumstance of the pods being first formed on the lower part of the stem, and, of course, first ripened; and they also shed very freely if roughly handled, or if the husks be either parched by the sun or opened by rains. When the greater part is of a brownish colour, it is then time to reap the crop, which should be done while the dew is on the plants, and the swathes should not be turned if they can be got sufficiently dry without it. When the plants are perfectly dried, the seeds are thrashed out on a cloth placed in the field, or the work may be conveniently done by the thrashing machine. After being thrashed and cleaned, they are to be spread closely upon a boarded floor for some time, until they are thoroughly dried, as a slight degree of fermentation in the heap would deprive them of their vegetative powers.

Closely allied to the sainfoin is the French honeysuckle, *Hedysarum* *coronarium.* Its flower-stalks sustain spikes of rich scarlet flowers, sometimes white, which expand in June and July in the second year, and perfect their seeds in August or September, after which the plant decays. It is chiefly known in this country as an ornamental garden plant.

This well-known beautiful plant is grown in the fields in several of the countries of southern Europe, for the purpose of feeding mules and horses. It is said to be very nutritious, and yields an immense crop, being from four to five feet in height. It is used either for green forage, or for being made into hay. The French honeysuckle has been recommended for cultivation in this country, but it does not seem deserving of much attention; for, independently of its being a biennial plant, and, consequently, yielding only one good crop in two seasons, it is tender, and easily injured by frosts in the spring months; so that it could be grown only on the warmest dry soils in sheltered situations.

The plants coming next under consideration are the Clovers, which are by far the most important of the cultivated forage plants, under the alternate system of husbandry. When land is to lie for a limited period without tillage, the clovers supply a much larger quantity of green food than could otherwise be obtained by the cultivation of any other of the cultivated forage or herbage plants; they are also considered as restorative crops in an eminent degree, for, besides the large return of manure which their consumption affords, they also act beneficially on the land on which they grow, it having been repeatedly ascertained that the grain crops succeeding clover are more valuable than after any other preparation. They are, in general, better suited to mowing than to pasturage, as the roots of the plants are frequently injured by animals in consuming the foliage; and when the crop is cut down, either for the purpose of soiling or being made into hay, two or three cuttings are obtained in the season.

The clovers cannot be advantageously cultivated when the design is to lay down the land, for any considerable length of time, in permanent pasture, without a large admixture of the grasses, these being of longer duration, and, at the same time, affording a better sward. In making a selection of plants for permanent pasturage, the quantity of the clovers must therefore be small in proportion to that of the other herbage plants.

The clovers belong to the genus *Trifolium*, of which there are a great many species, although the number cultivated in this country, for the purpose of yielding forage and herbage, is comparatively small. Those most frequently cultivated are the red and white clovers; and, in a less degree, the yellow and crimson clovers.

The Red Clover, *Trifolium pratense*, is a native species, and perennial; but the produce of the seed imported from the Continent becomes biennial, although, by being prevented from ripening its seeds, it frequently lasts to the third year or even longer. It is easily distinguished from the others, by the colour of the flowers being a deep red, and by its broad leaves, which are partially streaked of a lighter colour towards the centre.

The knowledge of the culture of this plant was originally derived from Flanders, and its cultivation extended rapidly after it was introduced. The introduction of this plant was, indeed, the first step towards the improvement of British husbandry; for it is not alone profitable from the abundant produce which it affords, but land which has been exhausted by the growth of corn is greatly restored to fertility by the shade and destruction of weeds occasioned by a weighty crop of this plant; and red clover,—if its general adaptation to our soil and climate be taken into consideration,—is, in these respects, superior to any of the cultivated forage and herbage plants.

In the immediate vicinity of towns, red clover is frequently the only cultivated herbage or forage plant to be found; and, on all the richer class of soils throughout the country, it is beneficially cultivated. On soils of an inferior description, it is cultivated in conjunction with the grasses.

The Creeping White Clover, *Trifolium repens*, is also a native species, hardy, perennial, and suited to a great variety of soil and climate. The return produced from white clover is much smaller than that from red clover; the latter is, therefore, preferred when the soil is rich, and the intention, as already stated, merely to allow the land to remain without tillage for one year. The white clover is suited to soils low in the scale of fertility, and on the poorer class of soils it is, accordingly, extensively cultivated. It is never grown by itself, being invariably mixed in larger or smaller proportions with the other herbage plants.

The seeds of white clover retain their vitality for a great length of time. After the application of calcareous matter to the soil, plants of it will spring up without the seeds being sown; and this can be accounted for only from the circumstance of the seeds lying dormant in the soil, and afterwards vegetating on being placed in a more favourable situation.

The Hybrid Clover, *Trifolium hybridum*, is so named from being intermediate between the preceding species. It is a native of the south of Europe and perennial. It seems to be deserving of the attention of the agriculturists of this country; and might form a substitute for the red clover, in cases where the land is laid down for perennial pasturage; as from the dissimilarity between it and the red clover, it may be found to succeed on such soils as are tired of the latter, or, in the language of farmers, are termed *clover-sick*. Should such be the case, it will be a most valuable acquisition to the stock of our cultivated plants.

The Zig-zag clover, *Trifolium medium*, is an indigenous perennial plant, and bears considerable resemblance to the common red clover. It is distinguished from the red clover by its more rigid zig-zag stems, narrower and darker green spotless leaflets, and, above all, by its creeping roots. From the trials that have been made of this grass, it does not seem deserving of more extended culture; however, its value as a forage and herbage plant cannot be regarded as satisfactorily determined.

The Lesser Yellow Clover, *Trifolium minus*, often known by the name of cow-grass, is not deserving of cultivation; and is merely mentioned to distinguish it from a variety of the perennial red clover to which the term cow-grass is also applied. The latter is a favourite and esteemed variety, and hence the necessity of distinguishing it from the lesser yellow clover.

The Crimson, or Flesh-coloured Clover, *Trifolium incarnatum*, is a native of the southern and central parts of Europe. It differs from the common red clover in having more elongated spikes and peduncles, in the different form of the stipules and leaflets, and in the greater hairiness of the calyx. The latter species has two nearly-opposite leaves close upon the globular spike, while the crimson clover has the uppermost leaf several inches distant from the spike, which is oblong. But a sufficient characteristic of the plant, compared with other species in cultivation, is the crimson colour of its flower.

The crimson clover has been known in this country for a length of time as a beautiful border annual of the garden; but it is only within these few years that it has attracted attention as an agricultural plant. Being an annual, it must be sown in the autumn, that it may come into flower and arrive at maturity the ensuing season. It cannot be sown with grain crops, like the other clovers, as, from its rapid growth, it would soon overtop and smother them; besides, if sown at the early period of the season, which is necessary when the smaller seeds are sown among corn crops, it arrives at maturity the same season, and, being an annual plant, it does not then grow in the succeeding one.

But the advantages to be derived from the cultivation of this species of clover are, that, when sown in autumn, it may be cut and removed off the ground in the month of May, or beginning of June following; in which case, the land can afterwards be prepared in due time for a crop of turnips. For this purpose, in favourable situations, it may be sown on oat stubble, which is intended for turnips the ensuing season. A light ploughing may be given to the land, and the seeds afterwards covered by a single turn of the harrow; or they may be sown at once on the stubble, without any previous preparation, it being only on tenacious soils that the ploughing can be regarded as beneficial. This appears to be slovenly management, but perfect pulverization of the soil has been found injurious as a preparation for this plant; and the best crops have been uniformly obtained when the soil has been loosened as little as possible, consistent with the due covering of the seed.

The crimson clover may be deserving of attention for the purpose mentioned. It forms a valuable article of green food at an early period of the season, and, if cut when in full flower, it sometimes yields a more abundant crop, and makes a superior quality of hay, than the other species. The produce, in general, however, taking into consideration the number of failures which occur from unfavourable seasons, has not been such as to warrant an extension of its culture on any considerable scale; and the trials which have as yet been made are to be regarded merely as experiments, until its properties are more fully ascertained. It is certain that it can never enter largely into the system of agriculture practised in the United Kingdom. It is sown without any admixture of other plants, and the quantity of seed may be from eighteen to twenty pounds to the acre.

Other species of the genus Trifolium might be enumerated, which have been occasionally recommended as agricultural plants, but experiments are yet wanting to confirm the various accounts of their productiveness and nutritive properties. Those which experience has shown to be suitable to the climate, and to form profitable articles of culture, are the red and white clovers.

The seeds of the clovers, it has been said, are usually combined with those of certain other plants before sowing. The crop may be cut and consumed in its green state, it may be made into hay, or it may be allowed to remain uncut until the seeds are fully matured, which are then saved for sowing.

Although the saving of clover-seed may be adopted in this country, the practice is extremely rare, as it is attended with considerable difficulty from the humidity of the climate. With the exception of the crimson clover, the various species will not mature their seeds in a proper manner until a late period of the season; it is, therefore, necessary to cut down the first growth, and to depend for seed on the produce of the second. The portion thus reserved for seed must be allowed to remain uncut until the husks become brown in the colour, after which it is cut down and harvested in the usual manner, and, after being sufficiently dried, it is stored up to be thrashed at the farmer's convenience.

When the seeds are not fully ripened, and the husks perfectly dried, it is difficult to separate them from each other; and even when managed in the best manner, a portion of the seed will often remain in the husk. The process of thrashing is performed by the flail, and the seed is winnowed in the same manner as grain, but with sieves adapted to the purpose. When the clover is raised for seed, it is, in common with all other plants cultivated for the same purpose, an exhauster of the soil; and from the late period of ripening, and the extreme state of dryness to which the plants must be brought, the saving of clover seed is a somewhat precarious operation. For these reasons the chief supply is imported. When the clovers are cultivated for the production of seed, there should be no admixture of the other forage or herbage plants in the proportion of the crop reserved for that purpose; but even should a mixture have been made, it may not prevent the seeds from being saved, as from the period at which the operation takes place, and the previous treatment of the crop, the others will not have ripened their seeds at the same time.*

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* "Among the cultivated forage and herbage plants, the clovers unquestionably hold the highest place, for from no others can so large a return be obtained. After these plants were first introduced into British agriculture, excessive crops were reaped off the lands, even where they were in an inferior condition to what they generally are now; but as improvements in agriculture advanced, the clover crops fell off, and that in cases where the system of tillage was otherwise good. This has contributed to prevent the extension of these crops in many situations in which it is conceived they might make a profitable return.

"The defective quality of the seed has been a fruitful cause of many of the failures of the clovers. Clover seeds are vended of all ages and qualities, and frequently the inexperienced are deceived in the quality of the seeds they purchase, generally under the lure of cheapness. The fresh seeds have a plumpness and brightness of colour which cannot easily be mistaken; but in this case much depends on the character of the seedsman.

"The ravages of the slug are also a very frequent cause of the failure of the clover crop. The cultivation of potatoes, turnips, and clover, on the same field, has contributed to increase these creatures to a destructive degree, while lands occasionally subjected to a summer fallow, are by no means so infested with them. Their attacks at the period of brairding are the most dangerous. Lime in powder is frequently applied to the ground with a view of destroying them; and when this is done, the application should take place in the mornings or evenings, when the slugs are eager at their work of destruction. The application of salt to the land is also found to destroy insects and other animals injurious to vegetation, as well as improve the quality of the land itsef. In wet seasons the slug generates rapidly; and in some cases they effect the destruction of clover crops with a rapidity equal to what has been described of the locust in eastern countries. Rolling might destroy them in vast numbers, but the application of salt and lime is simple, more efficacious, and at the same time beneficial to the soil.

"The state of the land with regard to cropping, may be a cause of the failure of the clover crop. This is brought about by the too frequent repetition of the same kind of crops on the same land, until, to use a common phrase, the land gets tired of producing them. Particular attention has lately been directed to the investigation of this important subject, by the writings of some foreign naturalists, whose experiments upon vegetable physiology have led them to the conclusion, that the roots of plants contain secretions formed by the sap, which, being thrown off as excrement, render the land unfit for the production of similar crops. When the

Of the genus *Lathyrus*, Vetchling, or Everlasting Pea, several species have been enumerated as agricultural plants. Some of these are perennials, and several are annuals. They have been found, in some cases, to make a large return of foliage ; but their adaptation for the purposes of the farm has not yet been sufficiently ascertained to recommend them as objects of culture. But of the whole genus it is to

soil has become much impregnated with the exudations of any particular vegetable, they are supposed to poison it so far as to be injurious to the same species of plant, and the land is then said to have been over-cropped, though these exudations may assist the nourishment of other plants. Many curious experiments have been tried with a view of ascertaining the truth of this hypothesis, the most interesting of which to farmers are those upon beans, potatoes, and grain. The bean exists in clean water, which continues nearly clear, although it assumes a yellow tinge, occasioned, as was found, by the discharge from the plant, of a gummy matter, and a little carbonate of lime. Fresh plants of beans did not live well in the same water ; but in order to ascertain whether this was occasioned by the exuded matter, plants of wheat were put in the water, and they throve perfectly ; the colour of the water became lighter, the sediment was reduced, and it was evident that the wheat plants had absorbed a portion of the matter discharged by the beans. From this it may be inferred, that the experiment justifies the practice of sowing of wheat after beans.

" As all the other experiments had nearly a corresponding result, we need not detail them here. But we shall endeavour to illustrate this interesting and curious question from the effects of tillage and cropping on old rich grass lands, possessing, it may be said, a purely virgin soil. The excellence of the crops in the first rotation must strike the most common observer. The second rotation will be little inferior ; but the third will show symptoms of a falling off; in the fourth rotation this will be still more evident ; and the fifth will bring the land to the torpid state we are now treating of. These are facts which require no proof. But to rectify this state of things, were the land laid down to pasture in the fifth rotation, and continued in it for a period of not less than four years, nearly the same state of fertility would again be the result.

" We might here take notice of a crop amongst which clover invariably succeeds, not only in its seedling state, but also in the following year's crop, namely, flax. This fact cannot be disputed, although the cause of it is not easily ascertained. It is a circumstance both curious and interesting, how a plant will grow luxuriantly in company with one species, and cannot be made to grow under any circumstance with another. Plants, like animals, derive nourishment from the decay of each other ; and it is an interesting research to examine minutely the relation which one plant bears to another, and to the soil on which they are destined to grow.

" Among the circumstances favourable to the growth of the clovers, deep ploughing, and the consequent exposure of fresh soil, may be mentioned. After the land has been summer-fallowed, clover is regarded as a sure crop, and this, no doubt, be observed, that the characters are somewhat suspicious. The leaves and stems are often bitter, and some of their seeds are poisonous.

A few species of the Melilot have also occasionally entered into cultivation. The common Melilot, *Melilotus officinalis*, is a native species of easy culture, and, though commonly considered as an annual or biennial, it is sometimes of three or four years' duration. Cattle are generally fond of this species of the melilot, when cut in a green and tender state ; but like all the rest of the genus, when allowed to arrive at full flower its stalks become so hard that the tops and leaves are only fit to be eaten. It might be cultivated with advantage on poor dry soils, either alone or in mixture with some of the grasses and other herbage plants.

The Blue-flowered Melilot or Sweet Trefoil, *Melilotus cærulea*, is an annual plant, and distinguished from the other species of the genus by its blue-coloured flowers. It is well known in the flower-borders of the garden by the name of sweet trefoil; but its cultivation as an agricultural plant is but little practised in this country, although it is produced as such to a large extent in Germany. It is of rapid growth, and might be sown where the common clover has partially failed. It should be cut before being in full flower, as the hollow tubular stalks then become very hard and woody.

The Bird's-foot Trefoil, *Lotus corniculatus,* is an abundant perennial plant in the higher natural pastures of this country. It might be advantageously cultivated on light and dry elevated inferior soils, and on such will yield a greater bulk of herbage than any of the cultivated clovers. It is highly nutritious, and is eaten with avidity by cattle.

arises in part from the circumstance of a large quantity of fresh earth being brought to the surface, and mixed with the other soil. The addition of fresh earth tends to remove that property imparted to the soil by over cropping, a result which cannot be counteracted even by the most liberal application of manures, and consequently to render it better fitted for the growth of clover.

"Surface applications have also a salutary effect in promoting the growth of clover. Soot is one of the ingredients which is applied to the greatest extent in the vicinity of large towns, and it has uniformly the effect of strengthening and forwarding the crop. Liquid manures are also applied with the best effects. In the Netherlands the clover crops are highly prized by the farmers ; and there, under the most unfavourable circumstances, large crops are produced merely by applications of liquid manures, in the management of which the farmers of that country excel."—*Jackson's Treatise on Agriculture, &c.*

From the great depth to which its roots penetrate, it is not liable to be injured by drought, and is thereby enabled to retain its verdure after the grasses and other plants are burned up.

The Greater Bird's-foot Trefoil, *Lotus major*, grows naturally in moist situations, and attains its greatest luxuriance in such soils as have a portion of peat in their composition. This species is regarded by some as nothing but a variety of the preceding one, and they account for the apparent difference from the circumstance of the natural place of growth of the *L. major* causing a greater development of its parts; but, besides its more luxuriant habit of growth, it differs materially from the former species in the form of its roots, which are fibrous and creeping, while those of the *L. corniculatus* are thick and fusiform—characters which both retain in every situation.

The Common Whin, *Ulex Europæus*, is also employed for feeding horses, cattle, and sheep, during the winter months. It does not, however, form the subject of cultivation, and is to be regarded rather as a troublesome plant, and one which the farmer is more interested in extirpating than in aiding its extension. It is, therefore, only when the plant is produced naturally that it is employed in feeding live-stock; and as it is found to be exceedingly nutritive, and highly relished by animals, it may be beneficially employed as provender in the absence of the cultivated forage or herbage plants.

Whins are given to horses and cattle in a green state, after undergoing a process of bruising until the prickles are so far reduced that the animals can eat them with safety. Sheep, on the other hand, are merely turned out to feed on whins when the snow is too deep to admit of their feeding on grass; and although they are found to thrive and fatten well on the whins, they seldom touch them except from necessity; but, when once accustomed to them, they continue to eat them in greater or less quantities, according to the state of the pastures, till the young grass comes in towards the end of spring. Hence, in upland situations, where whins are plentiful in the winter, shepherds always look with anxiety for a snow storm in the early part of that season.

The only instance in which the whin forms an object of culture is when it is used as a hedge plant; but some of the poorer upland soils, on which the more productive plants do not succeed, might, it is conceived, be profitably devoted to its cultivation.

II.—GRAMINEOUS PLANTS.

The numerous tribe of plants of which we are now coming to treat are found clothing the surface of the earth in every zone, attaining generally a greater height, with less closeness at the root, in warm climates; and producing a low, close, thick, dark green nutritive herbage in cooler latitudes. They contribute, in a material degree, to give the surface of the earth that rich dark green colour which is everywhere so delightful. The best pastures are such as are found in countries that have least cold in winter, and no excess of heat in summer.

The universal presence of the gramineous plants, and the rapidity with which all soils become covered with them when left uncultivated, are the obvious reasons why their systematic selection and culture are but of recent date. Though the Romans cultivated clovers, and were careful of their meadows, it does not appear that the seeds of the proper grasses were cultivated and sown by them. Such plants as are exotic, and but partially diffused, will always command the attention of the cultivator at an earlier period than such as are more common, and it is only when an improved system of cultivation is practised that the latter will command the attention their importance deserves. This, at least, seems to have been the case with the cultivated grasses in this country, the clovers, and other comparatively rare plants, being first cultivated; and, as the value and importance of these became more generally known, attention was directed to the improvement and cultivation of the plants indigenous to the soil.

With respect to the general culture of grasses, though no department of agriculture is more simple in the execution, yet, from their nature, considerable judgment is required in the design. Although grasses abound in every soil and situation, yet all the species do not abound in every soil and situation indiscriminately. On the contrary, no class of perfect plants is so absolute and unalterable in its choice in this respect. The creeping-rooted and stoloniferous grasses will grow readily on most soils; but the fibrous-rooted species, and especially the more delicate upland grasses, require particular attention as to the soil in which they are sown; for on many soils they will either not come up at all, or die away in a few years, and give way to the grasses which would naturally spring up in such a soil when left in a state of nature. Hence, in sowing down lands for permanent pasture, it is a good method to make choice of those grasses which succeed best in adjoining and similarly-circumstanced grounds.

New and improved varieties of many of the grasses, especially those used or fit to be used in the convertible husbandry, might, no doubt, be obtained by selection and cross-impregnation; and it is much to be wished that cultivators would turn their attention to this subject.

In the annexed account it is not by any means intended to particularize the different species of gramineous plants which have formed the subjects of culture, but such only as more especially demand the attention of the farmer, either from their possessing qualities entitling them to cultivation under certain circumstances, or on account of their possessing properties injurious to the soil, or to such crops as they are generally found growing amongst.

In the following arrangement the different genera, as well as the species of each genus, are placed so as to follow each other according to their relative value, or the estimation in which they are generally held by cultivators, commencing with the sorts which are most prized.

The Common Perennial Ryegrass, *Lolium perenne*, is one of the most important of the gramineous plants. It possesses several good qualities to recommend it to the attention of the cultivator, the principal of which are—its suitableness to a great variety of soils; the facility with which it is propagated, by reason of its seeds being produced in abundance, and their uniformity in ripening; and the fibrous structure of its roots, which fits it, in an eminent degree, for alternate husbandry. However, notwithstanding all these good qualities, its culture is, doubtless, in many instances, carried too far, to the exclusion of sorts which would yield a greater return, and might be grown in similar circumstances to greater advantage.

There are two kinds of rye grass which must be distinguished from each other in practice. The one flowers for successive years, and is therefore perennial; the other flowers in the second year, and, having borne its flowers, the roots decay; it is therefore a biennial plant, but it is generally termed annual ryegrass. There are no means of distinguishing the biennial from the perennial kinds by their seeds alone, and great losses have been frequently sustained by mistaking the one for the other, when the purpose has been to keep the land for several years in grass. The different kinds of perennial ryegrass are therefore those only suited for sowing on such lands as are subject to rotations in which two or more successive seasons of grass crop are required; and in such cases the seeds should be saved from plants of at least two years' standing, by which means the produce is of more permanent duration than that of seed saved from the crop of the first season.

The annual or biennial ryegrass differs from the more permanent varieties by having fewer root-leaves, and a greater quantity of culms, or stalks, which are rather longer, and furnished with a smaller proportion of foliage than those of most of the perennial varieties. It is from the quantity and length of its culms that this sort has been considered as yielding a greater bulk of crop the first season, and therefore better suited for single crops of hay than the perennial sorts. But the results of late experiments tend to show that the quantity of root and stalk leaves which these latter produce, fully compensates for any deficiency which may arise from the weight of their culms, besides rendering the hay less wiry and more palatable than that of the annual ryegrass, which, in fact, seems to possess no superior quality, except that it yields a greater quantity of seeds.

When the production of seed is the principal object in the culture of ryegrass, it ought not to be mixed with the clovers or any other of the grasses. It may be sown with any of the kinds of corn, and treated the year after in every respect as a crop of corn; being bound up in sheaves, built into stacks, thrashed, and dressed with the winnowing machine, in the same manner.

To procure the seeds of ryegrass for sowing it is, in some cases, the practice of farmers to collect those which dropped from the hay used by their horses; but ryegrass grown for hay is cut, by all judicious farmers, when it is just coming into flower; and, therefore, to collect the glumes, or empty husks, can be of no use as seed. It has also been a common practice to let the crop of ryegrass and clover stand until the seeds of the former have attained a considerable degree of ripeness, when it is cut down and made into hay in the usual manner, and the seeds separated by the use of the flail before the hay is used. Sometimes, when but a small quantity is wanted, the hay is merely shaken well upon a cloth when it is building in the stackyard, or afterwards in the stable-loft, before it is put into the racks. But in all these cases, in order to obtain good seed, the clover must remain uncut beyond the proper season; and it is thus materially injured in quality, while the value of the ryegrass seed, in such a crop, is merely a secondary consideration.

The difficulty of distinguishing the seeds of the annual and perennial ryegrass from each other has led to the practice of cutting the first year's crop, and allowing that of the second year to remain for seed. If the growth of the plants be close and vigorous the second year, there is reason to be satisfied that the seed is of the perennial variety; and though red clover was sown with the ryegrass, a great part of it disappears by that time, and forms but a small portion of the second year's cutting.

The Italian Ryegrass, *Lolium Italicum*, is cultivated in Italy and other parts of Europe; but its introduction into this country as a field plant is comparatively of recent date. It is probably in most cases a biennial plant, but when cut down before flowering, it is often of several years' duration. It reproduces itself freely from its seeds, which are scattered immediately on their becoming ripe. Compared with any of the other varieties of ryegrass, it affords a stronger braird, arrives sooner at maturity, has a greater abundance of foliage, which is broader, and of a lighter or more lively green colour; it grows considerably taller, and is more upright, or less inclined to spread on the ground. Its spikes are longer, the spikelets more thinly set, and upon the whole producing a smaller quantity of seeds, which are smaller and awned. The seeds of this variety also are generally little more than half the weight per bushel of that of the common perennial ryegrass, when grown under similar circumstances. Another of its distinguishing characters is, that it is preferred by cattle to any of the common sorts, a fact which has been proved by numerous experiments in various parts of the country.

This species of ryegrass is better calculated for being grown alone than in combination with the clovers or other plants, which, from the rapidity of its growth, it would soon completely smother and destroy. When it is intended that the land should only remain one season in grass, it may be cultivated to advantage, and for this purpose it appears to be a valuable plant. It is not only superior to the other sorts in the quantity and value of its foliage, but is also valuable both as an early grass and retaining its powers of growth to a late period of the season. When cultivated by itself, the quantity of seed may be from eighteen to twenty pounds to the acre.

The Meadow Cat's-tail, or Timothy grass, *Phleum pratense*, is a native plant, though its cultivation seems to have been introduced from America, where it is, in many places, exclusively cultivated. It succeeds best on moist and newly-reclaimed and moorish soils, in which it has a fibrous root; but, when cultivated on dry light soils, its roots become bulbous or tuberous. According to several experiments on the nutritive properties of the plant, it has been found to afford a great quantity of nutriment when its seeds are ripe, than it does if cut when in flower; hence it presents an increased stimulus to its cultivation from its seeds being procured without its being lessened in value as a hay crop. This plant produces abundance of foliage during the entire season, and although some of the other cultivated grasses produce herbage of a better quality, yet this grass is deserving of attention, especially when the design is to produce a permanent sward.

The Meadow Fox-tail, *Alopecurus pratensis*, is a native and very generally diffused plant, being found in most meadows. This is one of the earliest and best pasture grasses, but not so well adapted for hay, as it produces but few stalks, which are sparingly furnished with leaves. Its root-leaves are very broad, long, soft, and slender, and grow rapidly when cut or eaten by live-stock. It grows naturally on rather superior soils of medium texture, and constitutes the greater portion of many of the richer natural pastures in Britain. It produces abundance of seeds, which may be easily gathered while the grass is growing, as it overtops most others; the quantity, however, which is found in hay is usually very small, as the seeds generally ripen and fall out before the other grasses are ready to be mown. It is found to succeed well in watered meadows, and is much relished by horses and sheep.

The Rough Cocksfoot, *Dactylis glomerata*, is a well-known grass, found growing abundantly on all waste places, when not barely cropped by cattle. It is a valuable grass in cultivation, on account of the great quantity of produce which it yields, and the rapidity with which its leaves grow after being cut. Its habit of growth is tufty and rather unsightly, with broad foliage of a whitish green colour, which renders it unfit for ornamental parks or pleasure grounds. This is one of the superior pasture grasses, and is suited for forage as well as for herbage. It requires to be kept closely cropped; for, when allowed to stand too long, it gets hard and coarse. When subjected to perpetual pasturage, the cocksfoot does not seem to last above five or six years, but gives place to the smaller and finer-leaved grasses, with which it should always be sown in combination. It is well adapted for growing in shady moist places, and under trees.

The Meadow Fescue, *Festuca pratense*, is an excellent grass either for alternate husbandry or permanent pasture, but more particularly the latter. When growing naturally it is generally found on superior rather moist soils, and on such often forming a considerable portion of the natural pasture. Its leaves are succulent, and are well liked by all kinds of domestic herbivorous animals, and its root is perennial and fibrous.

The Spiked Fescue, *Festuca loliacea*, resembles the ryegrass in appearance; but it is easily distinguished from it by its spikelets having occasionally a short footstalk, always two glumes, and in improving in proportion to its age, which is directly the reverse of the ryegrass. In habit of growth, and bulk of produce, it much resembles the last species; but differs from it in having its inflorescence spiked, and in being more naturally adapted for growing in marshy situations. Further experiments are, however, yet wanting to confirm its value as an agricultural plant, before its extensive cultivation can be recommended.

The Tall Fescue, *Festuca elatior*, also resembles the meadow fescue in some respects, but from which it may be easily distinguished by being of much larger growth. It is also perennial, and fibrous-rooted; growing naturally on moist superior soils, and in waste places. It is rather a coarse grass, but may be sown either for hay or permanent pasture in situations favourable to its growth. It yields an abundant crop, and, notwithstanding its seeming coarseness, is relished by cattle generally.

The Hard Fescue, *Festuca duriuscula*, may be classed among the best native grasses of the dwarf kind for general purposes. It succeeds on a great variety of soils, chiefly preferring those of the lighter class; and produces a much greater weight of fodder than might be expected from its dwarf habit of growth, compared with some of the others; and is found to resist the effects of severe drought in summer, and to retain its verdure in winter in a remarkable degree. It constitutes a great portion of the best natural pastures in this country, especially where the soil is light and dry. From the fineness of its foliage, and greenness in winter, it is well adapted for sowing in parks and pleasure grounds, especially for sheep pasture; but, for short grass to be kept under the scythe, it should, from its wiry nature, enter sparingly into the mixture.

The Sheep's Fescue, *Festuca ovina*, is one of the smaller grasses found in elevated situations. Its quantity of produce is much inferior to that of any of the other cultivated fescues, and is only adapted for growing on elevated moorish sheep pastures, being greatly relished by these animals. It cannot, hower, be regarded as of any value as a plant for cultivation, and is only referred to here because it has been generally spoken of in terms of approbation.

The Rough-stalked Meadow-grass, *Poa trivialis*, is one of the superior pasture grasses, forming a part of our richest meadows. Its root is fibrous, and its stems are roughish, and hence its name. Its stoloniferous shoots begin to grow pretty early in spring, and, by lying prostrate on the ground, form a beautiful carpet. As the season becomes more advanced, however, these shoots become dried from the effects of much sunshine, but shoot out again towards the end of the season, when the weather becomes more moist, and continue green during most of the winter—a habit of growth which fits it for mixing with the upright growing sorts, such as the Italian rye-grass.

The Smooth-stalked Meadow-grass, *Poa pratensis*, is distinguished from the last species by its having a creeping root, and by the sheaths of the stem being smooth to the touch. It has been greatly recommended for sowing as a pasture grass, from its yielding a large quantity of herbage at a very early period of the season; but, in this respect, it is equalled by other grasses which are considered to be more productive; besides, it possesses several bad properties which render the propriety of its culture at least doubtful, except, perhaps, on very dry soils. Its creeping roots are impoverishing to the soil, and its foliage ceases, in a great measure, to grow after the month of June; it is, moreover, apt to be injured by rust, and it grows in large patches, entirely banishing all the other grasses within its reach.

The Annual Meadow-grass, *Poa annua*, has an annual root, and continues to flower frequently throughout the entire season. It is the most common grass in all temperate climates, and is often a most troublesome weed. In some part of Suffolk it forms whole fields, to the total exclusion of all other grasses whatever, and is greedily eaten by cattle and sheep, hence it has been recommended as a pasture grass. It has been beneficially employed for sowing on greens and bleaching grounds, in towns and places where the perennial grasses are apt to be destroyed in winter. In the summer, it will ripen its seeds in four or five weeks from the time of sowing.

The Floating Meadow-grass, *Glyceria fluitans*, generally known by the name of *Poa fluitans*, is found growing in ditches, stagnant waters, and other moist situations, and on alluvial fresh-water marshy soils. It is eaten with avidity by horses, cattle, sheep, and swine. It has been said not to thrive except when partially immersed in water; but there are few grasses better adapted for irrigated meadows, and even on moderately dry ground, it will yield a considerable produce. Its seeds are very nourishing, and form the manna, or manna croup of the shops, which are used in soups and gruels. They are rather difficult to collect, from ripening irregularly, and being easily shaken when ripe. In Germany and Poland, they are gathered by putting a cloth under the panicles, and shaking or beating them off with a stick, much in the same manner as juniper-berries are collected in this country, repeating the operation at intervals as the seeds become ripe.

The Reed Meadow-grass, *Glyceria aquatica*, usually termed *Poa aquatica*, like the last species, grows naturally in, and by the sides of pools, and on rich alluvial soil, more especially on banks of rivers occasionally flooded. In situations favourable to its growth, this plant attains to a great height, being one of the tallest of our grasses. It is a native of most parts of Europe; and in the fens of Cambridge and Lincoln great tracts are covered with it, which not only afford rich herbage in summer, but abundant crops of hay for winter forage. In these places it is sometimes cut three times in the season.

The Siberian Lyme-grass, *Elymus Sibiricus*, is a perennial plant, with a fibrous root, and flowers in June. It does not produce its foliage till rather a late period in the spring, but it grows rapidly afterwards; and its leaves, which are numerous, long, and broad, cover the stem up to near the spike, and are, together with the culm, much relished by cattle, either in a green or dry state. Although termed a perennial, it is not so permanent in its duration as some of the other grasses, being more of the habit of the ryegrass in this respect; and, like most varieties of the ryegrass, it may, no doubt, be better fitted for alternate husbandry than permanent pasture.

The soils best adapted for the growth of the Siberian lyme-grass seem to be such as are of a free texture, and rather dry than otherwise. When grown on cold and wet tenacious soils, its foliage is apt to be injured by rust.

The Marsh Bent-grass, *Agrostis alba*, grows abundantly in moist situations. Of this species there are a great number of varieties, to several of which distinct specific names have been applied. They all seem to agree in acquiring a very stoloniferous habit when growing in moist situations, but becoming more fibrous and of a tufted habit when grown on dry soils.

One of the best known varieties of this species is the Fiorin, usaully considered a distinct species, and known by the name of *A. stolonifera*. It was introduced into notice by the late Dr. Richardson, by whom it was cultivated to a great extent, and who published various papers on the advantages to be derived from its culture.* It grows naturally in the moister soils, and extends itself, sometimes to the destruction of less powerful grasses, by its creeping roots and stolones. Its best property as a pasture grass is the late period at which it rises in the season, affording food when other grasses have ceased to grow, and in spring also it affords an early herbage. The soils and situations in which it is found to succeed best in a natural state, are such as are of a free or porous texture, having a considerable portion of peat in their composition, and are well supplied with water, rather of a running than of a stagnant nature, such as the sides of ditches in reclaimed peaty lands. As the seeds are not produced in this climate in great quantity, it has been recommended to cut down the stoloniferous shoots or stems into small pieces, and strew them on the ground, giving them a course of rolling, and, at the same time, observing that the weather be rather moist than otherwise. This, however, is a tedious, as well as a precarious operation, and the only reason for performing it is the alleged difficulty of procuring seeds, and their slowness in growing. But these objections are groundless, for the seeds of this and several other varieties of *A. alba*, are annually imported from the Continent; and all that is found requisite to insure a regular braird, is to have the land in a fine pulverized state before sowing, otherwise the seeds are apt to be buried from their smallness.

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* Several articles on the properties of this plant will be found in different volumes of the Edinburgh Farmer's Magazine.

From the nature and habits of the fiorin grass it seems better adapted for cultivation in this country than in either England or Scotland, but more especially the former. It will not succeed unless in a moist climate, as well as a moist soil; and, on this account, the various trials made in England have not realized the expectations formed from the accounts of its culture and produce in this country. In any case, however, it is scarcely advisable to attempt the cultivation of fiorin on any other than a damp or irrigated peaty soil.

There are other species of the genus *Agrostis* containing several varieties; but they can scarcely be considered as objects of cultivation in any situation, and are rather to be regarded as troublesome weeds, where they have been introduced, which it is rather the province of the farmer to extirpate than to propagate by culture.

The Golden Oat-grass, *Avena flavescens*, yields a considerable bulk of fine herbage, and deserves to form a portion of all mixtures on light dry soils, either for hay or pasture. It arrives early at maturity, and, although a perennial, yet, if allowed to ripen its seed, it is but of short duration, particularly if grown on stiff moist soils. It is the most useful as a hay and pasture grass of the genus to which it belongs, as well as the smallest seed of all the native species.

The Sweet-scented Vernal-grass, *Anthoxanthum odoratum*, is common in almost all pastures and natural meadows; and it is to the presence of this grass that the hay of the latter chiefly owes its peculiar fragrance. It yields but a scanty portion of herbage, and is not particularly relished by any species of live-stock, but they do not refuse it when mixed amongst other grasses. It is remarkable for giving out a pleasant sweet smell during the process of drying, similar to that of the sweet-scented woodroof. It has been recommended to be sown in sheep pastures, for the purpose of improving the mutton, a quality which it is said to possess, and which is founded on the fact, that pastures in which it naturally abounds are said to produce the finest mutton. On the whole, it would appear, that lands intended to remain in grass should not be laid down without a mixture of this species, particularly parks and pleasure grounds, were it for no other reason than the pleasant scent which it gives out, not only when cut for hay, but also when the seeds become nearly ripe.

The Crested Dog's-tail *Cynosurus cristatus*, has a wide range of soils. It grows naturally on dry pastures, and also on those where the soil is damp and tenacious, and has been found to thrive well on irrigated meadows. Its stalks are not eaten by cattle, but allowed to stand and ripen their seeds, hence it has been said that it is undeserving of cultivation, but this objection applies only to the stalks; as all domestic animals, and more especially sheep, are fond of the root-leaves, which, although short, are produced in abundance.

The Woolly Soft-grass, *Holcus lanatus*, is an imperfect perennial and rather late flowering grass, of a short and unsubstantial appearance, and found chiefly on poor dry soils. It is, however, a very common grass, and grows on all soils, from the richest to the poorest. It produces abundance of seeds, which are light, and easily dispersed by the wind; from which circumstance, when it is once introduced, the soil is with difficulty freed from it.

The list of grasses might be greatly extended, and many other species and varieties enumerated, but it is conceived that none have been omitted which can, in any case, be considered as beneficial objects of culture; and, indeed, many of those mentioned can only be cultivated in particular situations, as will be seen on reference to the details just given. Those which experience has fully shown to be of the superior class, and suited to general cultivation, are comparatively few; but the number will, no doubt, be increased as the properties of additional species become more fully known. The following list contains the names of the most approved species at present:

1. Lolium perenne—Ryegrass.
2. Lolium Italicum—Italian ryegrass.
3. Phleum pratense—Meadow cat's-tail.
4. Alopecurus pratensis—Meadow fox-tail.
5. Dactylis glomerata—Rough cocksfoot.
6. Festuca pratense—Meadow fescue.
7. Poa trivialis—Rough-stalked meadow-grass.
8. Anthoxanthum odoratum—Sweet-scented vernal-grass.

III.—CRUCIFEROUS AND OTHER FORAGE AND HERBAGE PLANTS NOT INCLUDED IN THE FOREGOING DIVISIONS.

The plants belonging to this division, which form the especial subjects of cultivation, are chiefly used as forage, being cut down and carried from the place where they were produced, before they are given to cattle and other species of live-stock. It comprehends a great number of useful plants, such as the cabbage, turnip, and rape, which have already been treated of; and also a number of others which are usually considered eligible objects of culture. Those which may be cultivated by the farmer with advantage, and not already treated of, are the Comfrey, Succory, and a few others.

The Prickly Comfrey, *Symphytum asperrimum*, belongs to the natural order *Boragineæ*, and is a native of Caucasus, from which it was introduced into Britain, as an ornamental plant, about the beginning of the present century; but it is only within these few years that it has attracted the attention of the agriculturist as a field plant. Its roots abound with mucilage, and are fleshy and forked, and penetrate deeply into the soil. The flowers, before they expand, are of a beautiful crimson tint, and, when fully open, they are of a delicate but rich cerulean blue. The seeds as they ripen assume a dark brown, and, finally, black colour; and, if not collected just as they become ripe, fall to the ground, and are lost. They are not found to be fertile, generally speaking, when gathered and sown in the following spring; but, if suffered to fall, and then removed with some of the earth from around the roots to another spot, a seed-bed may be formed, which will produce a plentiful crop of young plants.

The comfrey, from the trials that have as yet been made with it, seems to have a wide range of soil, and to grow luxuriantly in almost every situation. The soil from which the greatest amount of produce has been obtained is a deep sandy loam; but this is not, by any means, the only description of soil on which it can be successfully cultivated, as it succeeds better on inferior soils than almost any other plant.

With regard to propagation, the plants may be raised from seeds, subject, however, to the difficulty already alluded to; but they may be multiplied to any extent, by a separation of the roots. These may be cut lengthwise during any period of the season, but it is better that it be immediately performed after the central shoot is put forth. The cuttings succeed well, and make fine large plants in a few months; but care is to be taken, that a part of the crown shall be with each cutting, which is essential to the success of the process.

The very young plants make rather slow advances for a month in spring after their removal; but, if rains fall, and genial weather supervenes towards the middle of May, they set off rapidly, and extend in every direction; the flower-stem is soon developed, and will be perfected in July. But cuttings made by separation of the roots of larger plants are found to grow and expand with amazing rapidity. They resemble, in this respect, the gigantic rhubard, which has been usually observed to be accelerated by removal in spring.

The produce obtained from this plant is usually very large. The stems sometimes attain to the height of five feet, and produce abundance of foliage, which is stripped off at intervals during the growth of the plant, and carried home to the cattle. The amount of foliage alone obtained from it has, in some instances, been upwards of sixty tons to the acre, which is truly an astonishing produce. But besides the foliage, the roots are also valuable, and they will etiolate or blanch to perfection. Both roots and leaves are eaten by every species of live-stock, and they form a good and nutritious food.

The preparation of the soil, and the after-culture of the plant, are exceedingly simple. The former consists in due pulverization and being cleared of weeds, after which the plants may be put down by the dibble in rows. There will be little difficulty in keeping down the growth of weeds when the crop is growing, as from its large system of leaves it effectually checks the growth of the smaller plants.

Upon the whole, considering the precocity of the crop, the plant fairly rising early in April, if the weather be at all genial, and extending with great rapidity, the frequent recurrence of the gatherings, the great abundance of green fodder produced, and that for a period of seven months, and the quality of that fodder, which seems to be of the best description, the conclusion may be safely arrived at, that the prickly comfrey may be regarded as a valuable adjunct to the usual stock of forage upon the farm.

In order to secure the permanency of the plants the practice of pulling off the leaves, instead of cutting over the whole plant, should be adopted. The full-grown leaves around the stems may be pulled off three or four times, at least, during the season; and the stems, as they advance to a foot high, may be broken off to within a few inches of the soil.

The Succory, *Cichorium intybus*, belongs to the natural order *Compositæ*, and is a native of the British islands, as well as of many other countries. It is extensively cultivated in many parts of Europe, both for its roots and leaves ; the former of which are used as a substitute for coffee, and the latter as food for live-stock. Being a native, it is well calculated to resist the severity of our winters ; and it also bears drought well, its large leaves covering the ground, and its roots striking deep into it. It has a fusiform root, and it is a well-known fact that the luxuriance of stem and foliage of such plants, is in proportion to the thickness and strength of the root. Judicious culture, therefore, in the early stages of its growth, is necessary to secure future luxuriance.

When the drill system is adopted, which is, in every case, to be preferred, the rows may be from fifteen to twenty inches distant, to admit of horse and hand hoeing ; and the plants should stand at least six inches distant in the rows. The seeds may be either sown in a seed-bed in the early part of the season, and the plants removed to the place where they are finally to remain ; or they may be sown at once in the drills, as in the case of the turnip, which is the more convenient practice. The sowing may be deferred to the month of May, as if it be done at an earlier period of the season, the plants are apt to run to seed in the autumn months, whereby they will be materially weakened, and the first crop of the succeeding season considerably lessened. The operation of thinning should be attended to when the plants are very young, and they should be pulled in soft weather in preference to cutting them with the hoe, as the roots are very tenacious of life, and will push out new buds although cut below the surface. One considerable crop of root-leaves may be obtained in the end of autumn, the first season ; and three, four, or even more may be obtained, under favourable circumstances, during each of the four or five seasons following, particularly if the first cutting be completed about the time of the plants showing their first flowers, when their average height will be from three to five feet. In any case the cutting of the crop should not be deferred until it arrives at a more advanced state, as the stalks then become hard, and the future vigour of the plants impaired.

The period of duration, from the time of sowing, will be from four to six years, if cut regularly before arriving at full flower. If, however, the seeds be allowed to ripen, the plants will lose much of their vigour even after the first crop. When cultivated in rows, four or five pounds will be a sufficient quantity of seed to the acre.

It will be readily observed, that as the succory continues so long in a productive state, its culture cannot be attempted in a rotation of cropping, and it should therefore be confined to some steep declivity or corner of a field inaccessible to the plough. On waste corners, near large towns, no plant cultivated in this climate will bring the cow-feeder nearly an equal return of succulent food with succory; and it should also hold a prominent place in the garden of every cottager in the kingdom.

There are numerous varieties of succory, none of which, however, seem possessed of much permanency in their characters when raised from seed, at least so far as accords with present experience. The most distinct is one with long thick roots, distinguished in France by the name of *Chiccoree à café*, which is there grown for its roots as a substitute for coffee.

Besides those which have been enumerated, there are also a number of other herbage and forage plants which have occasionally been recommended as the especial subjects of cultivation, such as the burnet, bunias, plaintain, and spurry; and in many cases these have been found very productive. When once in possession of the ground, however, some of them are to be regarded as troublesome weeds, which there is much difficulty in extirpating; and, notwithstanding the favourable reports of their cultivation, under peculiar circumstances, experiments are yet wanting to show that they ought to take the place of leguminous and gramineous plants of known value.

IV.—MIXTURES OF DIFFERENT SPECIES OF FORAGE AND HERBAGE PLANTS.

Of the various plants which have been enumerated, some, it has been seen, are chiefly adapted for forage, some for herbage, and others may be employed partly for forage and partly for herbage. Several of the forage plants, from their habits of growth, are best cultivated by themselves, or with a very slight intermixture of other plants. Of this kind are the tare and other species of vetch, which are mown for forage; lucern, sainfoin, when used for forage, comfrey, succory, and others. The trefoils, again, and the other smaller leguminous herbage plants, are best mixed with some of the grasses; and it is a point of importance, in practice, to determine what kinds should be selected, and in what proportions they are to be mixed.

The most important feature in the culture of forage and herbage plants is the mixture of different sorts. The effect of this is accounted for from some species putting forth their foliage and reaching a maximum of produce at different periods from other kinds. From some being gregarious or social, and others solitary, and never producing a close sward, by sowing seeds of several species together of dissimilar habits of growth, there is secured throughout the season a succession of fresh herbage, rendered, by the erect and creeping foliage of different species, so dense and abundant, as greatly to surpass in quantity that obtained from the cultivation of two or three sorts only.

The most frequently employed of the leguminous plants for mixed forage and herbage are the red and white clovers, and, of the indigenous grasses, ryegrass. This grass, it has been seen, is well suited for general culture, arriving more quickly than most of the others at maturity, producing abundance of seeds, at all times easy to be obtained, and growing well under the shade of corn. For whatever period, then, the land is to remain in grass after being sown, it will generally be well to sow such a quantity of the seeds of the ryegrass as will produce a crop of that grass alone, independently of the other grasses which may be mixed with it.*

If the land is to remain for only one year in grass, then the ryegrass alone will be sufficient to form, with the clovers, good forage and herbage; yet it will add to the value of the produce even for a single year, to sow it with a small proportion of the seeds of some of the other indigenous grasses. From the circumstance of these plants arriving at maturity at different periods, this is a good practice, for the produce should not be dependent on that of only a few species of plants. The husbandman who clothes his field only with ryegrass and clover, employs a limited machinery for effecting the object in view, the former being comparatively unproductive in summer, the latter moderately so in spring ; but when he, for this purpose, uses a variety of plants, differing in their habits of growth, and periods of luxuriance, a numerous and powerful machinery is kept successively in full operation, and an abundant supply of forage and herbage is produced throughout the season.

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* Elements of Practical Agriculture.

In preparing the seeds of the grasses and leguminous plants which are sown in mixture, the quantities of the former are usually computed by measure, and those of the latter by weight ; but it has been found that a reference to weight is a more correct standard by which to ascertain the relative proportions of the whole. This may seem a serious innovation on the old practice, yet it would certainly be preferable. In grass-seeds, it is true, the greater weight of one variety is no criterion of its superiority over another variety of less weight ; but a greater weight in the same variety always denotes a superior quality. Thus, when seeds are light, and consequently inferior, the greatest number of them is obtained by adhering to a given weight, and hence there is the chance of nearly an equal number of plants springing up as when the seeds are plump and heavy.*

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* As the practice of computing the seeds of the grasses by measure is not confined to the farmer in preparing them for sowing, but is also used by the seedsman, the following table of the average weight, per bushel, of the different forage and herbage plants enumerated in the succeeding lists, may prove useful for the purpose of comparison ; and they also may be regarded as some criterion of the quality of the seeds.

Fiorin grass	13
Floating meadow grass	14½
Meadow cat's tail	44
Meadow fescue	12½
Meadow fox-tail	5¼
Red clover	62
Rough cocksfoot	11½
Ryegrass	24lbs.
Rough-stalked meadow grass	15¼
Spiked fescue grass	15
Sweet-scented vernal grass	6
White clover	64½

But a given weight or measure of seeds does not always indicate the number of plants that will spring up; because there is both a difference in the relative bulk and specific gravity of seeds, and there is also a difference in the number of seeds that grow from a given quantity. A reference to the specific gravity of the seeds would then appear advisable.

Climate, altitude, and particular circumstances influencing the locality, produce marked differences on the vegetation of countries. But the sphere within which plants are cultivated in a single country is comparatively limited; and the pasture grasses have, it is conceived, a wider range of cultivation than the cereal grains. Where land is under the plough, therefore, and can produce the cereal and other cultivated plants, the natural grasses will grow with vigour. In elevated moors, and similar situations, the case is different; but there are found to be particular species which will succeed in such situations, and mixtures of them can accordingly be made.*

The herbage is, in a certain degree, influenced by the nature of the soil, and the proportions of the plants to be cultivated vary according to the intention of the cultivator. When the land is only to remain in grass for a single season, then the proportions employed may be—

Annual ryegrass	18 lbs.
Red clover	10
White clover	2
	30 lbs.

A mixture of seeds in these proportions will yield a large amount of produce. The annual ryegrass is used in preference to the perennial, when the land is to be only one year in grass, being generally supposed to produce a larger amount of foliage. It may even be used in mixtures for two years' grass, as it becomes biennial when it has not been allowed to mature its seeds the first year.

But if the land is intended to remain more than one year in grass, some of the other plants are to be introduced which are known to be of proportionably long duration, and the quantity of the red clover is to be diminished in a corresponding degree. When the land is only to remain two or three years in grass, as will be the case in the alternate system of husbandry, the proportions on a soil of medium quality may be—

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* Quarterly Journal of Agriculture, vol. iv.

Perennial ryegrass	24 lbs.
Meadow cat's-tail	3
Rough cocksfoot	3
Red clover	2
White clover	6
	38 lbs.

In the case of laying down lands to perennial pasturage, without intending to break them up in the ordinary course of tillage, a still greater proportion of the gramineous plants is to be introduced. The cultivator will in this case have to make a suitable selection himself, from the different plants enumerated and described in this section, observing to use such as are found best suited to his particular situation. The annexed list is for a soil of medium quality, and in the case of very heavy or light soils, other plants which are found to succeed better may to a certain extent be substituted.

Perennial ryegrass	12 lbs.
Meadow fox-tail	2
Rough cocksfoot	4
Meadow fescue	3
Meadow cat's-tail	2
Rough-stalked meadow grass	1
Sweet-scented vernal grass	1
White clover	6
Red clover	2
	33 lbs.

In laying down lands for irrigation, which occasionally occurs to the farmer, such plants are to be selected as will bear the watering process. These, of course, will be chiefly aquatic plants. The mixture in this case may be—

Perennial ryegrass	6 lbs.
Fiorin grass	2
Meadow fox-tail	3
Meadow fescue	3
Meadow cat's-tail	5
Spiked fescue grass	3
Rough-stalked meadow grass	2
Floating meadow grass	2
	26 lbs.

The number of these specimens of mixtures for sowing lands might be increased, but it is conceived that those already given will be found sufficient, particularly as the cultivator will be able to decide whether any of the others should be introduced, from the account given of them in another place. Thus, it may be expedient, in particular cases, to withdraw, either wholly or partially, certain grasses, and substitute others; and this is more especially to be kept in view when the lands have a tendency naturally to produce any particular grass, which, although desirable to a certain extent, may, when too predominant, be but secondary with reference to the special object desired. And it is also very material to keep in view the altitude, exposure, and any other peculiarities which may present themselves in the constitution of the lands.

XIV.—MANAGEMENT OF GRASS LANDS.

I.—LANDS ALTERNATELY IN GRASS AND TILLAGE.

Having thus seen the different properties of the various plants which experience has shown may be profitably cultivated for forage or herbage in this country, with the soils to which they are respectively adapted, and the proportion of each which is necessary for the purpose, we now come to treat of the culture and application of the crop thus produced.

The preparation of the soil, and the manures which the cultivated grasses receive, are also those intended for another crop, being generally sown amongst corn crops. Unless, however, the soils on which these plants are cultivated be well pulverized, and have been some time under tillage, they do not succeed well; for it has been repeatedly ascertained that newly-broken-up leys or pasture grounds cannot be sown again with the seeds of the clovers and cultivated grasses until the soil is thoroughly comminuted, and the seeds of the former herbage plants destroyed.

In laying down lands to grass, therefore, the most important primary object is duly to prepare them for the reception of the seeds. Hence the soil ought previously to be brought into the highest possible degree of fertility; for, although land may be too rich for the production of corn, and of such crops as are cultivated for their seeds, it is quite otherwise in the case of grass, or other crops where the object in view is the largeness and luxuriance of the plants themselves, as it is in the cultivation of all those intended for feeding cattle. In such a case, indeed, the richness of the soil is a most important consideration; because, the richer it is made, the more abundant crops will it produce. It has also been seen, in a preceding part, that laying down land to grass is a mean of improving its fertility, and of rendering it again fitted for the production of corn; but these objects are only imperfectly attained when the land is laid down to grass in an exhausted state.

And further, in addition to land being rich, it is also an essential circumstance that it should be well pulverized by tillage, on account of the minuteness of the seeds of the plants to be produced; otherwise the irregularity of the surface will not only occasion an irregularity in the produce of the crop, but it will be liable to be damaged by excessive droughts before the plants can have extended their roots, or become firmly settled in the land.

The time of sowing the seeds of the cultivated grasses depends on the nature of the land, the state of the weather, and the kind of crop amongst which they are sown. When they are sown with a corn crop, which is the more general practice, the seed-time is invariably in the spring. When the crop of corn had been sown in autumn, the seeds of the clovers and grasses are sown in spring amongst the growing crop; and when the corn itself is sown in spring, the grass-seeds are also sown just before the last turn of the harrows is given to the grain crop. In the case of sowing amongst autumn-sown corn crops, the seed-time is regulated rather by the state of the corn crop, with regard to the effect of harrowing and rolling it, than by any particular time of sowing the smaller seeds. A lighter harrow is usually employed, for covering such seeds, than that used for corn crops. Rolling is also, in general, necessary; but there are instances of the seeds of the cultivated grasses vegetating and producing luxuriant crops without either harrowing or rolling. But it is invariably of use to the autumn-sown crops of grain to use the harrows in spring, to break the crust formed on the land by the winter rains, which should always be done before sowing the seeds of the grasses, and harrowing alone should rarely be depended on—the roller should also be employed.

The different kinds of seeds are mixed together before sowing, in the required proportions; and care should be taken to keep them intimately blended together at the time of sowing, by stirring them up from the bottom of the sowing-sheet or seed-box.

Although the spring is the usual seed-time for these plants, yet they may be sown in autumn. The latter season is preferred when they are sown by themselves, that is, without a corn crop. This practice has been recommended in the case of laying down lands to permanent grass, as being calculated to afford a thicker and better sward. The value of the grass crop is, no doubt, in some degree, affected by the exhaustion of the soil, occasioned by the production of the preceding crop of corn, but not in a degree commensurate with the value of the latter; besides, the period in the rotation at which the smaller seeds should be sown is immediately after the land is manured, and, in this case, the severity of the corn crop is less felt. Nor will the shade of the grain crop, when it is not sown too thick, materially retard the growth of the clovers and grasses.

After being sown, the seeds quickly vegetate. In favourable situations, they will have attained a considerable height before the commencement of the corn harvest, and, when the corn is cut down close to the ground, they are cut and win with the straw, and add considerably to the value of the latter for fodder. In other cases, they will not have much more than made their appearance, but, in general, they should have completely covered the surface by that time. After harvest, the ground may be slightly pastured with calves and sheep ; but heavy cattle, which would injure the surface, should not be put upon it, and calves or sheep only for a short time, otherwise they would bite the plants so closely, as greatly to injure their roots. Throughout the winter the land is to remain untouched.

The after-culture of these plants consists chiefly in picking off stones, or other obstructions to the operation of the scythe, which may appear on the surface. This is done in the spring succeeding that in which the plants were sown, as soon as the land is sufficiently dry to allow carts to pass along it without injuring the surface. Should it be convenient to have the stones gathered up before this, they may be collected into heaps in the furrows, until the state of the land admits of their being removed. After this the surface is to be rolled to break down the stubble of the preceding crop, and further to prepare the land for the action of the scythe. These operations should be performed as soon as possible after the beginning of the month of April.

Towards the end of the month of May, or beginning of June, the crop will have attained a considerable height, and will be fit for cutting. It is then either cut down to be consumed green by cattle in the houses, or made into hay. Occasionally, however, the whole crop, or a portion of it, is set apart for pasturage.

Should the latter mode of consumption be adopted, there is no period in the growth of the plants at which they will afford so early and rich an herbage as in this—the second year. It must, however, be under peculiar circumstances, that the practice of depasturing grass lands the first season can be considered good management. The general practice is to consume the crop in a green state in the feeding houses, or to make it into hay, depasturing it the ensuing season, and every succeeding one that it remains in grass.

When the practice of soiling, or cutting the crop and consuming it in a green state, is adopted, a portion of the field is usually selected for that purpose, the remainder being made into hay. In selecting any portion of the crop for soiling, a part containing a large quantity of the clovers should be chosen, as being better adapted for the purpose, while that in which the grasses predominate may be made into hay. The crop may be cut for soiling earlier than would be advisable for hay, as a supply of green food at an early period of the season is peculiarly valuable; and should the first cutting be deficient in quantity, the second will be so much increased, by having a longer time to grow.

In the month of May therefore the cutting of the crop for soiling may be commenced, and successive portions of it cut daily until the whole has been gone over. Before the last part of the field is cut over, the part cut first will have made considerable progress, and be then ready for cutting a second time. This second cutting is gone over the same as the first, and in favourable situations another or third cuting may be expected.

Soiling is in many cases advantageous, but it is not practicable nor expedient in every case, nor is it necessary that it should be so. Certain animals of the farm do not thrive unless enjoying the air and exercise attendant on pasturage; and, in most cases, a portion of the farm is unavoidably in pasture, as, for instance, grass land in the second and third year. This portion of the farm will then be sufficient for the wants of these animals, without depasturing one-year-old grass. The soiling and depasturing of stock may, to a certain extent, be combined, without, in the slightest degree, affecting the health of the animals, by turning them out to the pastures during the cool parts of the day, and supplying them with food in the house towards noon. Soiling, when once introduced to any extent, removes one of the principal objections to the practice, namely, the want of sufficient fertility in the soil.

The portion of the crop which is not cut for soiling is made into hay. In this case, the stones are removed, and the land is rolled in the spring, as already directed.

The period at which the crop should be cut down when it is intended for hay, is just when the plants have attained their full size. At this period they will be coming into flower, and if afterwards allowed to remain uncut for any length of time, they will be deprived of much of their juices, which are consumed in bringing the seeds to maturity, the crop becoming, at the same time, greatly more exhausting to the soil. The flowers of the plants should not, in any degree, have begun to fade before the crop is cut down.

The plants are laid in swathes by the action of the scythe. As soon as the swathes, or rows of cut herbage, are thoroughly dried on the top, they are completely turned over by a fork, or the handle of a hay-rake, in such a manner that they shall not be broken or spread abroad. The swathes thus turned over in the morning may be put into cocks in the evening, if the day be fine. It is a good plan to put up the hay green into these first cocks, and then to enlarge them by putting two or more together, as they become better dried. If, at this early stage, they undergo a slight degree of incipient fermentation, it will not injure the crop.

The mode of forming the hay into these cocks is simple and expeditious; and none but boys and girls, under the inspection of the farmer, or some confidential servant, are usually employed. If the crop is heavy, a row of cocks is placed on the middle ridge of three, and, if light, of five ridges. A distinct company of carriers and rakers is allotted to every such number of ridges; and the separate companies proceed, each on its own ground, and in the same manner as in reaping grain, which occasions a degree of competition amongst them for despatch, clean raking, and well-built cocks. The carriers gather the hay to the ridge on which the cocks are to be built, the latter process being performed by some of the more experienced hands. A raker follows the carrier, taking up and bringing to the cocks the remainder of the swathes. When it is desired to perform the business with expedition, there may, in general, be five persons employed about each row of cocks, a carrier and raker on each side of the row, and the person building. When the crop is light, more rakers are required, as a greater space must be gone over in collecting a certain quantity of hay.

The length of time which is necessary for the hay to remain in these cocks, is regulated by the state of the weather, as it is necessary that it should be completely dried before it is formed into cocks of a larger size. The first-formed cocks being placed in a line along the ridge, it is easy to put two or more of them into one afterwards. They are spread abroad during the best part of the day, if the hay is not yet sufficiently dried for being formed into larger cocks; but this is not necessary when the hay is sufficiently ready, it being at once made into ricks. For this purpose, the smaller cocks are dragged together by a horse with a rope, one end of which is attached to one of his traces, and the other end being put round the base of the cock, is fixed to his traces on the other side. He is then made to pull forward the cock to the place required, and, in this manner, two or more of them may be dragged forward at once. It is impossible to lay down rules for the management of hay after it is put into cocks. Sometimes it is formed into large ricks in the fields, by putting a number of the smaller cocks together; and sometimes the latter are at once conveyed to the stack, which is the preferable practice when it can be adopted. One thing, however, in the management of hay, should always be attended to, and that is, not to shake out, scatter, or expose it, more than is necessary for its preservation.

When the hay is not sufficiently dried to be carried from the small cocks to the stack, it must be formed into large cocks, or ricks, in the field. These are built by persons standing upon them, to whom the hay is forked by persons on the ground. They are formed with a conical top, to throw off the rain, and securely bound down by ropes formed of straw, or of the hay itself. In this state, they may be preserved for a length of time; but the hay should not be allowed to remain longer in the ricks than is necessary to dry it in a sufficient degree to fit it for being stored in a larger stack, as the hay forming the outside of the ricks will become damaged from exposure to the weather, and a large portion of the bottoms will be unfit for use.

When the hay is sufficiently ready, it is stacked in circular or oblong stacks, the latter form being generally approved of when the quantity is large, and carefully thatched, as has already been observed in regard to corn. It is never advisable to allow this kind of hay to become heated in any considerable degree in the stack, though a slight fermentation is usually observable, and hence the necessity of a previous preparation of the material in as careful a manner as the state of the weather will allow.

In forming the stacks, a layer of straw is usually spread over the bottom, or stand, and the hay is then regularly spread, and trodden down, observing to keep the middle of the stack well raised. In this manner, it is carried up to the height of several feet, projectin slightly to the eaves, so as to overhang the sides, to guard the lower part of the stack effectually from rain. The roof is then raised to a considerable height in a slanting form, with gable ends, and this part of the operation requires considerable care and experience in the building of the stack. Being thus formed, the loose hay which projects from the sides and ends of the stack is pulled, until the surface presents a smooth and regular appearance, and the part thus pulled out is used for completing the top. When the stack is finished, it is bound down with ropes to secure the hay from blowing away until it is thatched. It should be examined regularly for some time after it is put up, as if it had ever so slight an inclination to one side, this inclination will be always increasing, unless a support is placed against the stack.

Salt is sometimes strewed upon the hay as the building of the stack proceeds. It is efficacious in correcting the tendency to fermentation, by absorbing the moisture in the hay, and it also renders injured hay palatable to live stock. The quantity of salt used in this manner should be small, not perhaps exceeding a stone of salt to a ton of hay.

The measurement of hay in the stack, for the purpose of ascertaining its weight, may be made in the following manner. To the height from the ground to the eaves, add half the height from the eave to the top; then multiply the sum thus obtained by the length, and this product again by the breadth of the stack. The product now obtained will give the contents of the stack in the same denomination as the dimensions. After being allowed to settle in the stack during the winter, ten cubic yards of hay will generally weigh a ton. The specific gravity of the hay, or the weight contained within given dimensions, depends, however, partly on the state in which the hay was cut with regard to ripeness, and partly to its state, with reference to dryness, at the time at which it was stacked, as well as on the time it has stood in the stack. All these circumstances should, therefore, be taken into consideration before determining the quantity of hay contained in a stack by admeasurement. In the rick in the field, hay will seldom weigh more than a hundred pounds to the cubic yard.

More than one crop of hay is seldom obtained from the land in a season, although the second cutting may also be made into hay. It is vigorous or weak according to the proportion of the clovers to that of the other herbage plants, as well as the period of cutting the first crop. It is always, however, inferior to the first cutting; and, when the first cutting is made into hay, it cannot be considered good management to cut the after-math, which, with all the subsequent year's grass, so long as the land remains untilled, should be depastured.

The produce of the cultivated grasses is so exceedingly various that it is difficult to determine what should be considered an average crop. When made into hay, it is calculated that the crop loses three-fourths of its weight. Two tons of hay to the acre may perhaps be considered an average produce, and, in particular cases, so much as three tons have been produced.

Immediately after the hay is removed from the field to the stack, cattle may be turned into the field to eat down the herbage about the fences which escaped the scythe. This will usually afford a full bite to the cattle for several days, and if not consumed in this way it would be lost.

The length of time which the land is afterwards continued in grass depends on the course of cropping which is practised on the farm. According to the alternate husbandry it cannot be longer than one or two seasons; for, under any circumstances, it is not good management to keep land more than three years in grass. Whatever the period may be, it is always to be observed that, after the first year, it should be invariably depastured.

The management of pasture lands is easy. The chief particulars to be attended to are the stocking of the land at a proper time, and duly apportioning the number of animals to the extent of land. Further particulars relative to this subject will be found in subsequent pages.

II.—LANDS PERMANENTLY IN GRASS.

No method of producing hay has been found comparable to that of the cultivated grasses; yet a large proportion of the surface of this island is kept permanently in grass, partly for being made into hay, and partly for pasturage. Much of it has never been cultivated, but produces the heaths and herbage plants peculiar to it; such are all our mountain pastures, and the unimproved surface of the lower plains. But land is not only left in grass in parts of the country incapable of cultivation, or in cases in which it is supposed that cultivation would not repay the expenses incurred; but much even of the better land is kept in grass, from an opinion that the return from it in this state is larger and more certain than could otherwise be obtained.

The principal objection to the conversion of much of the land at present in grass to arable land, arises from an alleged inferiority both in the bulk and nutritive properties of the new when compared with the old herbage. It is certain that by no means can we at once produce a surface of grass which can be at all compared to some of the richer pastures in our grazing counties. Still, in by far the greater number of cases, where the soil will admit the convertible system of husbandry, and where that system is well understood and practised, we have no hesitation in affirming that an increased produce would be obtained by the conversion of such lands into tillage. When laid down again from tillage in grass, it may not support such heavy animals as it would previously have done; but it will support more in number, though of a smaller size, and will, on the whole, bring a greater weight to the market. From habit, too, a preference is given to the hay produced on the natural meadow. It is, however, a question of expediency whether any great extent of the inferior soils of this country, at present in pasture, should be converted into tillage, until an increased degree of attention and a better system of husbandry are practised on those already under cultivation.

The management of lands permanently in grass is somewhat different from that of grass land merely interposed in the course of cropping of arable land, to prevent that exhaustion of the nutrient parts of the soil which is commonly the consequence of incessant tillage. From the short period which the land is, in the latter case, in grass, manure is seldom applied to the surface, though it is often indispensable in the former. Various other operations are also performed to remedy those defects which are natural consequences resulting from lands being long kept in the production of grass. Such lands naturally divide themselves into two classes; those which are fit either for mowing or pasture, and those which are fit for pasture only.

1. *Perennial Grass Lands fit for mowing, or Meadow Lands.*

Under the term meadow are included all such lands as are kept in grass chiefly for the sake of the hay crop, though occasionally, and at particular seasons of the year, it may be depastured; and there is also generally included under this term the notion of a greater degree of moisture in the soil than would be desirable for permanent pasture or lands in tillage. The value of the natural meadow depends much on the situation as well as on the quality of the land. There are three descriptions of these meadows; those on the banks of streams and rivers; those on the uplands, or more elevated grounds; and bog-meadows. Each of these is susceptible of improvement in a greater or less degree.

Meadows situated along the banks of rivers and streams are, in general, by far the most valuable. They are the most productive of grass and hay, yielding sustenance for cattle throughout the year, and producing a lasting source of manure for the improvement of the adjoining lands. The conversion of this species of meadow into tillage would be improper, for in no other way could such large and valuable crops be raised off the land.

Along the banks of rivers the soil is deep and generally of the alluvial kind, having been deposited by water, or washed down from the adjoining eminences, and the surface is even, from the same cause. In most cases land thus situated has a gradual declivity to the river or stream, which almost invariably flows in the lowest part of the valley; and this circumstance, when it occurs, is of great importance in the processes of draining and irrigation. The principal defects to which such lands are liable, are the oozing out of the springs towards their junction with the higher grounds, and the inundations of the stream or river. The former evil is to be remedied by draining, and the latter by embanking. They are well suited to irrigation, that process being much easier in the case of such lands than on the more elevated grounds.

Upland meadows are next in value to holms. They are, however, greatly inferior to the latter, and, except under peculiar circumstances, such land would be greatly more productive by being brought occasionally under tillage. To constitute a good upland meadow, the soil must be naturally fertile, and land of this description is well suited for tillage. The cases in which tillage might not be preferable are, when the land is well adapted for irrigation, and the water to be employed of an enriching nature; and when a proper supply of manure for spreading on it at intervals is easily obtained.

The culture of upland meadows requires more attention, and is attended with more expense than that of valleys and holms; being more difficult to drain, and requiring frequent applications of manure. The roots of grasses never strike deep into the soil; and thus, deriving their nourishment chiefly from the surface, the utility of top-dressings is obvious. The irregular surface of uplands is frequently much injured by superfluous moisture, the consequence of which is, that the lands are generally covered by herbage of an inferior description and deficient in nutritive properties. Another defect is the surface becoming covered with the mosses, to the great injury and partial exclusion of the more valuable plants. The mosses are partly got rid of by harrowing the surface, and by the application of manures; but the effectual remedy for the destruction of these plants is a course of tillage.

Boggy meadows are, in general, the least valuable, but they are susceptible of great improvement, and, under proper management, the produce of them is large. They abound in coarse semi-aquatic plants, chiefly *Junci*, until they are thoroughly drained; but, this being effected, the more valuable plants are produced. Irrigation is attended with the most beneficial results in this case, as is also the application of calcareous manures.

When boggy land has been thoroughly drained, and the surface of it so far improved by culture as to produce the more valuable sorts of herbage plants, this is, perhaps, the most profitable way of occupying it. When under tillage the culture of this species of soil is attended with great difficulty, and the returns from it very uncertain in the first stages of its cultivation; but when its improvement has been carried so far as to warrant its being laid down in grass, large crops may be obtained from it at cōmparatively little expense.

More than one crop is rarely obtained from the natural meadows the after-math being generally eaten down by cattle. Should the second crop, or after-math, be so luxuriant that it might be mown, this is seldom done, as consuming it on the land contributes to its fertility.

The time of cutting the crop is later than in the case of the cultivated meadow. In this country it is often improperly delayed to a late period of the season, with the view of obtaining an increased produce. The proper time is when the saccharine and nutritive juices of the plants are in greatest abundance, which is immediately before the formation of the seed; for if the crop remains uncut until the seeds are ripened, not only will much of the nutritive juices of the plants be wasted, but the land will be much more exhausted than if they had been cut at a less advanced period of their growth. If the cutting of the crop be delayed beyond the proper time, in addition to the greater exhaustion of the soil and the loss of part of the nutritive matter in the plants, the best part of the season has passed for making the hay, and the process will be attended with greater difficulty.

The grass, after being cut, is allowed to remain for a short time in the swathe, and it is then scattered evenly over the surface of the ground. This is sometimes done with a fork, but it is better done by the hands, taking care to thoroughly loosen every lump, and to strew it evenly over all the ground. This secures the grass being all equally dried, and a shorter time will suffice for preparing it for the stack, by which its quality will be greatly improved.

Soon after the grass is spread, if the weather be fine, it is formed into what are called wind-rows with the rake. After standing a few hours, these may be formed into cocks, which, from the green state of the grass, must be small. They are formed by grasping a quantity of the grass which had been previously well shaken in a heap, and placing it on a part of the surface that has been raked; observing, at the same time, to gather it in well at the bottom. All the grass cut in the early part of the day may be put into these cocks in the evening, and that cut at a later period is prepared for being formed into cocks next day. The ground is raked over at the time the cocks are being made, and this operation should be carefully performed, as the grass left thinly scattered on the surface will be of very inferior quality.

On the following day the cocks are again spread abroad, but it is not necessary that the grass should be spread over the entire surface of the meadow, as in the case of the first shaking, for it is now much drier; and by spreading it rather thickly over the ground it is easier gathered again, and a part of the surface only will require raking. It is afterwards formed into wind-rows, as in the former case, and it is again put into cocks of a larger size in the evening. These will, in a day or two, be ready for putting into ricks, if the weather be fine; but should it be unfavourable, a much longer time may be required, and the cocks will probably require to be shaken out and formed into others of still larger size, before the hay is ready for the rick.

Great difficulty is often experienced in the management of the hay harvest, by the wetness of the weather. In such a case the farmer is obliged to watch the intervals of fine weather, and employ every practicable means to forward the operations and secure the crop.

As general rules, the grass should be exposed as little as possible to the weather; and it, therefore, should remain but a short time spread abroad until it is formed into cocks. Care should be taken to apportion the number of hay makers to that of the mowers, so that there may not be more grass in hand at any time than can be properly managed. The proportion is about five hay makers to one mower, and of this number three may be girls. The number necessary will, however, depend greatly on the weather. It is particularly necessary to guard against spreading more hay than the number of hands employed can get into cocks the same day, or before rain. In showery weather the grass may lie a few days in the swathe without injury; but, before it has lain long enough for the lower side of the swathe to become yellow, which, if suffered to lie long, would be the case, particular care should be taken to turn the swathes.

When the natural herbage is coarse, a slight fermentation in the ricks or the stack is considered beneficial, as it renders the stems of the plants more palatable and nutritious. The process must not, however, be allowed to proceed too far, otherwise the hay will be injured.

During the hay harvest the utmost attention is necessary on the part of the farmer in the superintendence of it. Constant personal attendance is essential, and the different parties are to be regularly visited, urging them on with their work, and directing them to perform it in a proper manner. The different processes are in a great measure regulated by the state of the weather, and advantage must be taken of every favourable opportunity. In collecting the hay for the purpose of forming it into ricks in the field, horses may be advantageously employed, as directed in the management of the cultivated meadow.

In certain situations the raising of hay on the natural meadow will be found the most economical and simple way of occupying such lands as are suited to it. Frequent manurings are however essential to maintain them in a state of productiveness, and from not attending to this circumstance, may be attributed the worthlessness of natural meadows in many situations. The manures applied with the best effects are those containing calcareous matter in abundance, as composts of lime. The application of lime or marl is indeed the only effectual way of guarding against the extension of the inferior plants to the suppression of such as are more valuable. The quantity applied will of course, depend on the state of the land and the frequency of application. The period of application is early in spring.

2. *Permanent Pastures.*

The lands appropriated to this purpose are usually inferior to those set apart for meadow. A considerable extent of the pasture lands of this country are of such a nature that their conversion to tillage is impracticable without a considerable outlay in the first instance, which might be long in being repaid from the produce of the land. This, added to the nature of the agreements between the proprietor and occupier, has prevented the improvement of this sort of land in many cases. Pasture lands may, however, be found in some of the richer grazing districts, suited equally for meadow or for tillage; but the extent of such lands is small when compared with those of an opposite description.

The drainage of lands permanently in grass is one of the greatest improvements of which they are susceptible. In the case of such lands, the operation is generally more simple than in that of arable lands. Cuts are made along the hollows of the field, which convey the water to the most convenient outlet, and small drains formed either by a plough or the spade, open into them. These need not be more than a foot in depth, observing to make them sufficiently numerous, especially in hollow places, and situations in which water is likely to be retained. Having removed the surface water, the tendency to *rot*, one of the most fatal diseases of sheep, will be removed.

The weeding of pastures should be regularly attended to; for when land is kept in grass, weeds of various kinds may tend to occupy the place of more valuable herbage. Weeds in pastures are injurious to the lands that they occupy, the seeds they produce also injure the surrounding grounds, and sometimes they are injurious hy influencing the quantity of milk and butter, and the health of the animals. Where the sloe-thorn, and such other shrubs as have a tendency to throw up suckers from their extended roots, form part of the enclosure fences, the suckers should be pulled up as they appear, otherwise they will become a serious nuisance. In some parts of the country, the waste ground along the fences, injured by the spreading of shrubs and trees, is often from four to six yards in width. Pastures are also occasionally overrun with whins, especially where they form part of the fences; but, in this case, the whins should be regularly dressed and pruned, to prevent the ripening and dispersion of their seeds. The young plants of the whin may be eradicated by the hoe; but they generally spring up again from parts of the roots left in the ground. They should be pulled up by the hand before they have much extended their roots, when the weather is moist.

The greatest difficulty in the management of grass land is to prevent the growth of the mosses. They are altogether innutritious, and, by being spread closely over the surface, they prevent the growth of more valuable plants. Mosses will readily be found growing in the richer pastures, but they are most apt to grow where the soil is inferior and moist.

Draining will, in this case, remedy the evil to a certain extent. The surface should also be well harrowed and cross-harrowed, after which a compost, formed of calcareous matter and cleanings of roads and fences, is to be spread on the land. After this, a mixture of grass-seeds may be sown, especially if the mosses previously occupied the greater part of the surface which will now be torn up. Folding sheep on pasture lands overrun with moss has also been found effectual for the destruction of it. But the radical remedy is to plough up such lands, and subject them to a course of tillage. It is in this way only that the inferior plants can be thoroughly eradicated, and their place supplied with better herbage.

The application of lime to the surface of grass lands in considerable quantities, either alone or in combination with other matters, is productive of the most beneficial effects. After the superfluous moisture has been removed, the least promising lands will amply repay the expense of a liberal application of lime, by their increased produce. Were this species of improvement more generally practised, disappointment would not be found to ensue, as is often the case in the numerous ill-divided and expensive schemes of improvement which may be frequently seen practised in various parts of the country, and which have the effect of withholding the application of capital in this department, even in cases where it might be advantageously employed. A top-dressing of lime, or of materials having a due proportion of lime in their composition, has a remarkable effect in consuming the native coarse herbage, by the decomposition of which a fine vegetable mould is produced capable of supporting in luxuriance the finer herbage plants. In fact, in the case of all soils containing a large proportion of inert matter, a liberal application of lime is only necessary to bring them into a state of fertility.

The removal of ant-hills should be attended to in the management of pasture lands. In some parts of the country, the ant is scarcely known, or, at least, found only in small numbers, while in others it is very troublesome. The hills raised by these insects have an unsightly appearance, and deprive the farmer of a crop in proportion to the ground they occupy. The hills forming little eminences like small hay-cocks, will sometimes cover a large part of the surface, and there is great difficulty in driving them from the habitations which they have so carefully constructed. The usual method of destroying them has been to dig up the hills, and cut them in pieces, which are then scattered about; but this practice only disseminates the ants, instead of destroying them, as they hide themselves among the roots of the grass for a little time, and then collect themselves together again upon any little eminence. The best plan for destroying them is raising the sods containing them by the spade, and burning them in heaps. If the ant-hills are removed in winter, and the contents spread upon the surface at that season, the frosts will kill them. Rolling the surface has also been resorted to as a mean of destroying them.

The surface of grass lands, from frequent rolling and the treading of the animals, will get into a tenacious state. In this case, scarifying will go far to remove the evil. This operation is particularly useful before a top-dressing of any description is applied.

The time of stocking pastures in spring must be earlier or later, according to the season; and the state of growth which it is desirable the plants should attain before being stocked, must, in some degree, be determined by the condition and description of the animals to be employed in consuming the herbage, whether they are only in a young state, or approaching to fatness, whether milch cows or sheep, or a mixture of animals of different species. The great objects to be aimed at are, that the stock, of whatever kind it may be, shall be carried forward faster or slower, according to the object in view; and that no part of the herbage shall be allowed to run to waste, or be unprofitably consumed. Cattle and horses require a larger quantity, and though they prefer the finer grasses, are satisfied with a coarser herbage than sheep. Sheep are, therefore, put on the finer and shorter grasses in preference to cattle.

The principal modes of improving the quality of pastures have now been described. In the case of elevated lands, a very important improvement is enclosing. A great improvement of all elevated lands is shelter for the stock; and judicious planting, accordingly, is also one of the means of improving these grounds.

Water should be provided for every field in pasture, so that the stock may always have a sufficient supply; and where there are no trees, rubbing-posts have been found a desirable addition.

III.—IRRIGATION.

The application of water to the surface of grass lands, for the purpose of promoting vegetation, has been practised from the earliest times. Without the artificial conveyance and distribution of water, some of the most fertile countries in the world could not have supported their inhabitants; and the earliest husbandmen, accordingly, knew and practised the watering of lands as an art. The practice of irrigation is supposed to have been introduced into Britain by the Romans; and, in some districts in the southern part of the island it has been carried to a great degree of perfection. It was subsequently introduced into this country; but it cannot be said that irrigation at present forms any considerable part of the labours of the Irish farmer.

In former times, and in all countries, irrigation, however imperfect, was probably much more frequent than it is now. In light and gravelly tracts of country, the greatest difficulty in farming was to procure a sufficient quantity of fodder for the cattle in winter. Meadows were, therefore, indispensable; and, to increase the crop of hay, the practice of watering would be constantly followed. But, since the practice of sowing the artificial grasses, and the introduction of the turnip husbandry, the practice of watering has fallen much into disuse; not only because it has become less necessary, but because hay thus produced is of inferior value, compared with the produce of the cultivated meadow. The introduction of green crops, in a great measure superseded the necessity of irrigation. The cultivation of these valuable plants not only enables the farmer to keep a greater number of live-stock to enrich his land and increase his profits, but the alternation of white and green crops predisposes the land to yield a more abundant produce.

But, notwithstanding the process of irrigation becoming less necessary as cultivation advances, it is certain that it may still be practised with good effect in many cases. Watering poor land, especially if of a gravelly nature, is by far the easiest, cheapest, and most certain mode of improving it. Land, when once improved by irrigation, is put into a state of perpetual fertility, without any occasion for manure, or trouble of weeding, or any other material expense. It becomes so productive as to yield the largest bulk of hay, and the after-math is also valuable. In favourable situations, it produces very early grass, which, at that season, is doubly valuable; and not only is the land thus rendered fertile without having any occasion for manure, but its abundant produce is converted into manure for other lands, thus augmenting, in a compound proportion, that source of fertility.

The main object of irrigation in tropical climates seems merely to be to carry to the ground that quantity of water which is necessary for the growth and nourishment of the plants to be produced; but this species of irrigation is very different from that to which the term is applied by the British farmer. In temperate climates, the purpose is not merely to supply the deficiency of water in the soil, for the water is conveyed over the surface at the season at which there is an excess of moisture, and not a deficiency. Instead of the object being to supply moisture to the plants, it is necessary, in every well-formed watered meadow, to drain the ground very thoroughly of all subterraneous moisture. Nor is this the only distinction between the two kinds of irrigation. In the one, the water is generally allowed to stagnate, until it shall have saturated the soil; and in the other, it is never allowed to stagnate, but is maintained in a constant flow over the surface.

In one respect, the two kinds of irrigation may be said to agree, and to serve a common purpose, that is, by the deposition of mud, or other fertilizing matters, upon the surface. The principal effect of the annual inundations of the Nile is the supplying to the soil a sufficient quantity of moisture, without which an arid soil in a country where rains are scarcely known, would yield a scanty produce. But this effect is greatly increased by the large quantity of mud which that river deposits. In the case, too, of the watered meadow, the water may, in like manner, deposit a fertilizing sediment; but this, though it adds greatly to the effect, is not essential to the producing of it; and waters entirely free from all perceptible sediment are yet successfully employed in the case of the watered meadow.*

Stagnating water on the surface of land renders the plants beneath it in some degree aquatic, or the herbage disposed to make such a change; but in the watered meadow, when properly constructed, the plants enjoy the full benefit of both air and water. Practice has proved that the only effectual mode of securing this, is by keeping water passing over the surface of the land, with a brisk current; not so brisk as to wash away the soil, and yet in sufficient quantity to nourish and cover the roots, but not too much to hide the shoots of the grasses.

In endeavouring to ascertain the cause of the beneficial agency of water in the process of irrigation, it must be remembered that heat, air, and light, are indispensable agents in the development, as well as in the maturation of plants. If they be kept in a low temperature, secluded from fresh air, or kept in a dark place, their progress towards maturity is stopped, and they languish. Applying these facts, while considering the effects of irrigation, it may be safely concluded, that the energies of the plants are excited by being defended from the chilling influence of frosts, or a low temperature of the atmosphere;

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* Quarterly Journal of Agriculture, vol. i.

and, at the same time, are not excluded from the direct action of the solar light. Nor can the thin covering be said to deprive the plants of the necessary portion of air; the agitated and rippling surface of the former fluid uniting with the latter. But it is probable, that the chief benefit derived from the process is the increased temperature produced by the action of water in running over the soil. The reason assigned for water affording this increased temperature and consequent protection to the herbage, is the fact, that the specific gravity of water of the temperature of from 40° to 42° is greater than when the temperature is lower; and as the heavier portion of the water will naturally be that flowing along the surface, the temperature of which is rarely below 40°, the herbage will thus be protected from injury.*

The soils most suitable for being watered are all those which are of a sandy or gravelly nature, as the improvement is not only more immediate, but the effect more powerful on those than on other descriptions of land. It is of advantage that the soil should be incumbent on a warm and absorbent bottom; for the subsoil of watered meadows is considered of more importance than the quality or depth of the surface soil. The best watered meadows are sometimes those in which the soil is only a few inches in depth, especially when the bottom is porous.

With regard to the quality of the waters most suitable for irrigation, those of rivers which flow through a rich and cultivated country are to be preferred, as they are enriched by the animal and vegetable matters which they receive in their progress, and which are contained in them in a state of solution. A considerable portion of these matters is left on the surface of the land by the waters passing over it, and it is thereby greatly enriched. Water from bogs is considered inferior, from the antiseptic quality communicated to it from the peat. Waters containing the oxides of metals, or some of their salts, in solution, are also inferior; although water impregnated with ferruginous matters has sometimes been used with good effect. But it has been already seen, that the effect is not altogether dependent on the quality of the water, how much soever it may be increased or diminished by it.

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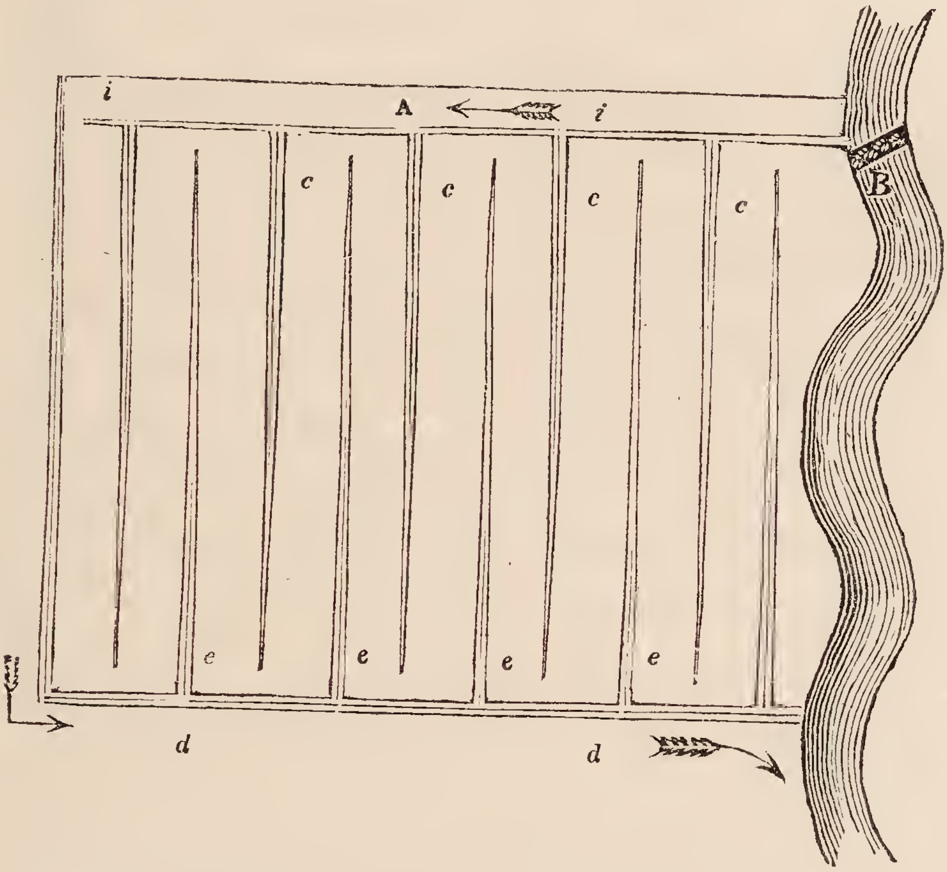
* This is the theory assigned by Sir Humphry Davy, but the subject is yet much involved in obscurity, none of the various theories proposed satisfactorily accounting for the phenomena produced. Since the promulgation of the theory of the excrementitious discharge from the roots of plants certain physiologists have endeavoured to prove that the beneficial effects of the process result from the action of the water washing away this excrementitious matter. Further observations, however, are wanting to confirm this theory. One beneficial effect resulting from water flowing on the surface of the land we may believe to be the rendering of it more porous. When soil of any given texture has been saturated for a time with water containing more or less sediment, a certain degree of porosity will be produced, which after dryness it will require considerable pressure to overcome.

It is essential that every part of the surface be covered with water, and that it be every where in a state of motion. It is only on the banks of rivers or streams, or in situations where a supply of water can be conveyed from them, that the process of irrigation can be carried on; for in no other cases could a sufficient quantity of water be obtained for covering any considerable extent of ground. The water is conveyed to the highest part of the land, in what is termed a main conductor, either by building a weir across the river, or by bringing it from a higher source. From this main conductor, various feeders are taken off, as nearly as possible at right angles. A large drain is formed at the lowest part of the grounds, corresponding to the main conductor, which is termed a main drain; and into this several smaller drains open, passing between the intervals of the feeders. These serve to conduct the water from the meadow into the main drain, by which it is again conveyed into the river.

In the annexed diagram, which represents a watered meadow, A is the main conductor, and B the weir placed across the river to intercept the course of the water, *c c c* are the feeders taken off as directed from the main conductor at right angles to it, by which a constant flow of water is maintained over the surface. The water is then carried off the meadow by means of the small drains *e e e* passing between the intervals of the former, and communicating with the main drain *d d*, which again conveys the water to the river. The dimensions of these smaller drains are seen to be greatest where they respectively join the main conductor and main drain, being then about four inches deep, and eight or ten inches wide, and gradually diminishing to a point as seen in the figure. But the dimensions of these drains, as well as the distance between them, must be regulated by the extent of the ground to be gone over, and the nature of the soil.

Fig. 76.



This is the usual form of the watered meadow, but the precise arrangements for watering must be regulated by the particular situation. It is frequently necessary, that the water should be collected and conveyed to another main conductor for watering a meadow in a lower situation; and when slight inequalities occur in the surface, or when it is wished to convey an additional quantity of water in any particular direction, stops are used for the purpose, which consist of small pieces of sods placed in the drains to cause the water to flow over. In the preparation of the surface for irrigation, it is usual to form it into low ridges, the feeders being on the crowns of the ridges, and the drains for carrying off the water in the furrows.

The plan illustrated in the preceding figure is calculated only for situations in which the inclination is not considerable. In the irrigation of lands with considerable inclination of surface, the feeders cannot be carried along longitudinally as in the former case, but across the line of descent, so that the water flowing from one is intercepted by the next lower, and so on until it has covered the whole of the meadow. This is termed catch-work irrigation, and is represented in *Fig.* 77. When there is not a uniform inclination of surface, main conductors must be carried from the river along the eminences, from which feeders proceed through the meadow. An example of irrigation where there are various inclinations of surface is represented in *Fig.* 78.

Fig. 76.

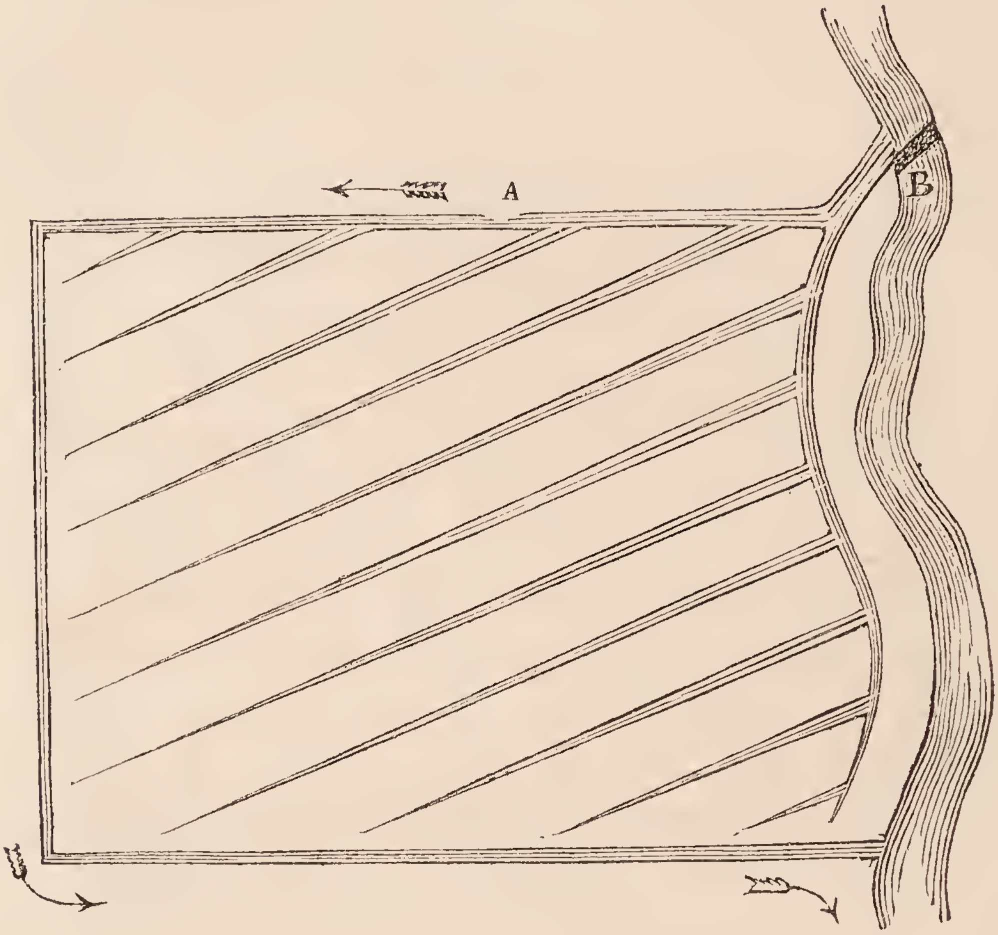
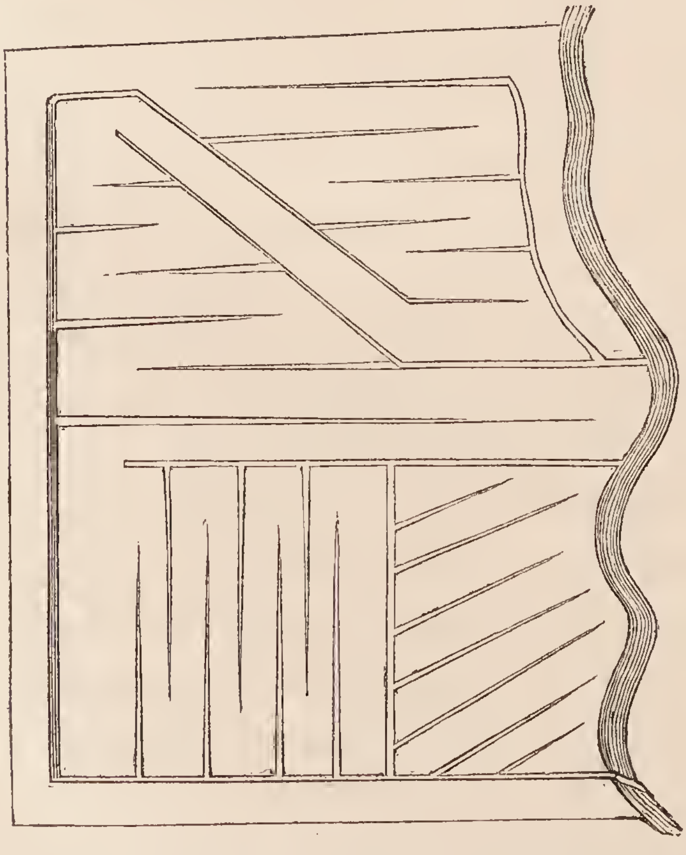


Fig. 78.



The process of floating the meadow commences generally in the month of October, being as soon as possible after the after-math has been consumed, or the last crop of hay removed. The water is first kept upon the ground for periods of a fortnight or three weeks at a time. It is then let off, and the ground left perfectly dry for five or six days; and this process of alternate flooding and drying is continued generally during the months of November, December, and January, care being taken to let off the water when it begins to freeze. As the spring advances and the grasses shoot forth, the periods of watering are shortened, so that the flooding shall not last above five or six days at a time. In the southern counties of England the meadows are ready for the reception of stock of all kinds in the middle of March; but more to the north, where the grasses do not make such early progress, the flooding is generally continued through the whole month of May. After this it is discontinued for the season, and one or more crops of hay are produced. Flooding during the months of summer produces a rapid and rich vegetation. But it is by summer flooding, where it is practised, that the fatal disease of *rot* is introduced, so that no sheep should ever touch the meadows which have been flooded during the summer months.*

The formation and arrangement of surfaces for irrigation, however simple in principle, are, in practice, among the most difficult operations of agricultural improvement. Whoever, therefore, contemplates the execution of extensive and intricate works of this kind, will find it desirable to call in the assistance of a person possessed of the requisite degree of experience. In Gloucestershire, and some others of the southern counties of England, where the art of irrigation is brought to great perfection, there is a class of men who follow this as a profession, and have under them a set of men accustomed to the work, who accompany their chief to every part of the country.

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* Quarterly Journal of Agriculture, vol. i.

XV.—THE MANAGEMENT OF LIVE STOCK.

I.—GENERAL CONSIDERATIONS REGARDING THE STRUCTURE OF ANIMALS.

An important characteristic of modern British farming, and that which constitutes its chief excellence, is the union of the cultivation of live-stock with that of vegetables. Formerly, in this country, and in most other countries, the growing of corn and the rearing of cattle constituted two distinct branches of rural economy; but as the culture of roots and herbage plants became extended, the importance of the domestic animals began to be felt, and the introduction of their rearing and feeding as a part of ordinary farm management, contributed more than any thing else to the improvement of agriculture.

The study of the animal kingdom is not less interesting to the scientific agriculturist than that of the vegetable, as he exercises an important and extensive control over that part of it to which his influence extends. The number of treatises, however, on the subject of the domestic animals of the farm is limited, compared with those which have appeared on vegetable culture. But, however little has been written on the subject, the improvement of these animals has not been neglected; on the contrary, it has been studied like a science, and carried into execution with the most sedulous attention and dexterity.

Organized beings consist of two great classes, vegetables and animals, which, in more perfect individuals, are easily distinguished from each other, but, as we descend in the scale of animated beings, we arrive at individuals which it is extremely difficult to place with certainty among the animal or vegetable tribes. In general, however, there are characters by which they are easily distinguished from each other; and which are derived from certain properties possessed by the one, but of which the other is destitute. Every living being must possess the power of assimilating foreign materials into its own substance: and since it is a law of the vital economy, that life springs form life only, it must be endowed with the further property of generating an offspring inheriting a nature similar to its own, otherwise every species of creatures would perish with the primitive race. The faculties of nutrition and reproduction must, therefore, be common to all living beings. Vegetables, accordingly, exercise these two functions, but to these their economy is limited. Animals, on the other hand, possess two additional faculties, namely, sensation and voluntary motion; from which superadded endowments they are said to be *animated*, and they are therefore called animals.

The simplicity of the structure of the vegetable exhibits a striking contrast to the complexity of the animal organization. For the simple functions performed by the vegetable, a simple structure is sufficient; for the complicated functions exercised by the animal, complicated organs are indispensable. The addition of the peculiar faculties of the animal, rendered a modification of the common or vegetative faculties absolutely necessary—a modification which could not be effected without increasing the complexity of the mechanism. The vegetable, fixed to the soil which contains its nourishment by roots which absorb that nourishment, requires no special organ for holding and accumulating its alimentary matter. The animal, not being fixed to the soil, endowed with the power of locomotion, constantly changing, and delighting to change its place, must transport with itself the means necessary for its support.*

A second modification, equally indispensable, arises out of the necessity of conveying the alimentary matter to the different parts of the body. A considerable force is required to propel the nutritive fluid over its extended surface. For the supply of this force new expedients must be adopted; there must be a circulation of the nutritive fluid; for this purpose, vessels must be furnished to contain the fluid, and an engine must be constructed capable of generating a force sufficient to communicate to it the requisite impulse. It is easy to see that a communication must next be established between the digestive organ and the vessels which carry on the circulation. And thus, if we were to trace the animal organization to its highest state of complexity, we should perceive that that complexity was absolutely requisite for the due exercise of the higher faculties with which these higher orders of beings are endowed.

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* In whatever point of view we consider these two classes of organized beings, we find them blended in so many ways, and separated from each other by such imperceptible gradations, that it is impossible to draw a line at which it can be affirmed that animal life ends and the vegetable begins. A rigorous definition of the animal structure cannot, therefore, be given, but certain general characteristics may be pointed out which serve to distinguish animals from vegetables. It must, however, be remembered that the structure of certain animated beings, the polypus for example, is as simple as that of any vegetable, and although the faculty of voluntary motion is a general characteristic of animal life, it is not, by any means, a universal one.—Corals do not leave their habitations.

If we examine an animal high in the scale of organization, we are struck with the variety of its parts, and with the complexity of their structure. By analytical investigation it is ascertained that these parts, various and complex as they appear, consist only of the elementary bodies which are found in plants, with the addition of nitrogen, which is, however, in most cases also present in vegetables. These elementary and inorganic substances combine together in different numbers, and in various proportions, under the unknown circumstances which constitute the condition of life, and thus form all existing varieties of organic matter.

The component substances of the animal body are invariably disposed in two forms—fluids and solids. The fluids are contained in the solids; both are mutually dependent; both possess an analogous composition; both are in continual motion, and pass without ceasing from the one into the other. Every animal consists of a union of both, which union is indispensable to animal life.

It is difficult to ascertain the absolute quantity of the fluids contained in the animal body, because it varies according to circumstances, and, in the same animal, it is different at different periods of life, and according to the state of health and of disease. Invariably, the younger the animal, the greater the quantity of the fluids. The embryo of animals, when it first becomes appreciable by the senses, appears to be almost entirely fluid. As it grows and is developed, solid parts are gradually added. The quantity of the fluids successively diminishes until the animal arrives at a mature age.

The fluids differ greatly in their density. Some exist in the state of gas; others in the state of vapour; some are extremely thin and transparent, as that of the serous membranes, or the membranes which line the great cavities of the body; others possess considerable consistence, as some of those secreted by the mucous membrane. Some exist in exceedingly minute quantity, as the delicate fluid contained in the internal organ of hearing; others form a large portion of the bulk of the body, as the blood. Some are intimately combined with the animal solids; others are contained in membranous bags or reservoirs; and a great number are contained in distinct vessels.

The animal fluids are composed, for the most part, of water, in which the various component substances of the body are held in solution. Many of them are found to consist of masses of globules, which are, in general, so small, as only to be discerned by microscopical observations.

The chemical properties of the fluids are important, as all the great actions of life are intimately connected with them. Their influence over all the processes which are constantly going on in the animal economy is so great, that if the body be called a machine, as, from the admirable adjustment of its various parts, it may be termed with a striking appropriateness, it may at least with equal truth be denominated a laboratory, in which the most important and extensive chemical actions are taking place every instant. In general, the chemical composition of the fluids is the same as that of the solids; both contain the same proximate principles; and in the living body there is a continual transformation of solids into fluids, and of fluids into solids. Whatever may be the case with the other fluids, the blood at least exhibits phenomena which are perfectly analogous to those of the living solid. If blood be taken from an artery or vein, and kept at rest at the same teperature which it possesses in the living body, after a certain time it undergoes the process of coagulation; that is, it separates into several distinct portions, some of which are fluid and others solid. It is conceived that this change takes place after death even in the body of the animal, and life is therefore essential to fluidity. It is certain that it does not owe its fluidity to its circulation, as has been proved by experiment.

The solid parts of the animal body are derived from the fluids. They are formed out of them by a peculiar process termed secretion. After the solids are once formed, they depend upon a continual supply of the fluids for their healthy condition. They are composed of the same physical substances as the fluids—they are reducible, by chemical analysis, to the same elements, and form, by the primary combination of these elements, the same proximate principles.

Varied and almost innumerable as the different solids at first sight appear, yet, when attentively examined, it is found that they may all be included in the following substances; namely, bones, with their cartilages and ligaments, which may be considered as appendages to the bones; muscles, with their tendons; and membranes of various descriptions. And these substances, again, widely different as they appear both in composition and structure, may all be reduced by analysis to the cellular, the muscular, and the nervous tissues, which correspond, in a certain degree, with the parts similarly named forming the elementary structure of plants, which has been already described.

In the construction of the animal frame, the tissues are variously combined and modified. Some are disposed in a definite order, and moulded into a peculiar form; others are disposed in another order and moulded into a different form. These definite arrangements constitute organization, and form the various organs of the animal body. The figure, magnitude, and general aspect of the different organs are exceedingly various. Their physical properties depend upon the tissues of which they are composed, and upon the modifications which these tissues undergo; and their chemical properties upon those of the tissues, and of the fluids.

The bones are the hardest and most durable of the animal solids; they constitute the frame, serve as points of attachment to the muscles, and afford support to the softer solids. They are the instruments, as muscles are the organs, of motion. In the fœtus they are at first a vascular gelatinous substance, in different points of which earthy matter is gradually deposited. The earthy part is the last formed, and consolidates the bones as the animal becomes fit to exert his powers. This deposit of earth in the bones appears to be hastened by anything that permanently quickens the circulation: heat does this, and hence the human and brute inhabitants of warm climates come to perfection sooner than those of northern regions; but they are generally smaller, for by preternaturally hastening the earthy deposit before the membranous part of the bones becomes evolved or fully grown, they do not attain the bulk they would be otherwise capable of. Undue exertion has the same effect; and thus we learn why horses, too early and too hard worked, become stunted in their growth. Pressure, likewise, occasions an early and also a preternatural ossification; in this way the parts of the spine which bear heavy loads present large masses of bone, brought on by this cause alone.

Bones are all more or less hollow, and within their cavities an oily fluid is secreted called medulla, or marrow, which serves for their support and that of the constitution generally. The bones have nerves, blood-vessels, and absorbents. They are capable of reproduction, as is proved by their uniting when broken; and also by the yearly renewal of the antlers of the deer, which are not horn, as in the ox or the sheep, but pure bone. They are connected together by articulation, and when such articulation is moveable it is termed a joint. In some cases bones articulate by suture, or indentation of parts, as in the bones of the skull.

The bones, when large, are usually considered an indication of strength; but strength does not depend on the size of the bones, but on the size and vigour of the muscles. Many animals with large bones are weak, their muscles being small. Animals which have been imperfectly nourished during their growth have their bones disproportionally large. If such deficiency of nourishment originated from a constitutional defect, which is the most frequent cause, they remain weak during life. Large bones, therefore, generally indicate an imperfection in the organs of nutrition.

Cartilage can scarcely be said to differ in its nature from the cartilaginous basis of the bones. It is of a fine fibrous structure, smooth on the surface, and remarkably elastic. It covers those parts of bones which are exposed to friction, as the joints, and is thickest at the point of greatest pressure. By its smoothness it facilitates the motion of the joints, and its elasticity prevents the bad effects of any violent concussion. It is intimately united with the bone, and can scarcely be regarded as different from an elongation of the cartilaginous basis.

The ligaments differ from cartilage in their greater elasticity and density. They serve to give additional security to the osseous system, and at the same time to facilitate motion.

The muscles are the organs by which motion is executed, being susceptible of contraction and relaxation, and unfolding, in the singular mechanism of their parts, an infinite variety of movements. They assume a variety of form suited to their peculiar functions. Sometimes they are flat, extending over a considerable space, and often they form a fleshy band, swelling out in the centre, and becoming small and tendinous at the point of their attachment to the bones, as in the figure. Anatomists enumerate several hundred muscles which are employed in the various functions of animal life; and, from the motions of the limbs to the expression of the face and modulations of the voice, all are moved by this machinery of surpassing simplicity and beauty.

Fig. 79.

The processes of animal nutrition yet remain to be noticed. The instinct of animals for satisfying the cravings of hunger and thirst is sufficiently strong to ensure the due supply of the wants of the system. The food, being reduced to a pultaceous mass in the stomach, and mixed with a variety of secreted fluids, by means of the digestive organs, is in this state denominated chyle. This mixture exhibits a chemical constitution nearly approaching that of blood, into which it is destined to be converted, by the separation of the useful from the useless part. This is effected by certain vessels called lacteals, which absorb the nutritious part of the chyle, and convey it to a particular receptacle. Another set of absorbents, the lymphatics, take up all the substances which have been ejected from the circulation, and which are no longer necessary in the particular organs, and communicate their contents to the store already provided by the lacteals. The veins receive the altered blood from the extremities of the arteries or the glands, in which they terminate, and proceed with it towards the lungs to be again aërated. In their progess they obtain the collected fluid of the other absorbents, and, in the lungs, again prepare the whole for the use of the system. Thus, during the continuance of life, the arteries supply the materials by which the system is invigorated and enlarged, and oppose that tendency to decay produced by the influence of external objects. The process continues during the whole of life, new matter is daily added, while part of the old and useless is abstracted. The addition is greatest in early life, the abstraction is greatest in old age.

The stomach is generally proportioned to the quality of the animal's food, or the ease with which it can be obtained. In those that live upon flesh and such nourishing substances it is small and glandular, affording such juices as are best adapted to digest its contents; and in those that feed entirely on vegetables this organ is very large. Such animals as chew the cud have no less than four stomachs, all of which serve as so many laboratories to prepare and turn their coarse food into proper nourishment. In fact, in all animals, the size of the intestines is proportioned to the nature of the food. In domestic animals that are plentifully supplied they are large; and in wild animals that live precariously they are much contracted.

An examination of the physiological structure of animals is not less interesting than useful to the scientific agriculturalist. It is surely interesting to become acquainted with the characteristics and peculiarities of those animals which form such a considerable part of the capital of the cultivator, and it is also useful as making him acquainted with the principles by which he should be guided in their breeding, rearing, and feeding.

The wild animal is subject to few alterations, and in a state of savage nature, continues for ages the same in size, shape and colour. But it is otherwise when domesticated and taken under the protection of man—its external form, and even its internal structure are altered by human assiduity; and this is one of the first and greatest causes of the numerous varieties among animals of the same species. The very nature of our domestic animals seems to have been changed by cultivation and care. All the varieties of colour, all the fineness and length of their hair, and many other peculiarities seem to have arisen from a long continuance of domestic slavery. The wild animals preserve the marks of their first formation, their shape and colours being constant; but in the case of the domestic animals, their colours are various, and their forms different from each other.

II.—PRINCIPLES TO BE OBSERVED IN THE IMPROVEMENT OF BREEDS.

The great object of the husbandman, in every case, is to obtain the most valuable return from his raw produce; he will, therefore, prefer that description of live-stock, and that variety, which will repay him best for the food consumed. The value to which the animals themselves may afterwards be brought is a distinct and inferior consideration. An important inquiry then is, how is this object best attained? In elucidation of this inquiry, the principles of breeding, rearing, and feeding, with a view to the production of an improved stock, shall be successively explained.

The chief object of breeding cattle is the acquisition of profit. The raising of them is an art, and, like all the other arts, is attended with labour of mind and body. The purchasing of breeding stock at the outset, and of collecting them together from different districts to one farm,—of rearing the young stock from the period of their birth to full maturity, and of disposing the surplus stock at markets,—is a labour attended with considerable outlay of capital, and exertion of body and mind; and no one, unacquainted with all the minute details necessary to be observed in the breeding and rearing of cattle, can conceive the peculiar labour of conducting this department of farm management. But the anxiety of the mind is protracted beyond the labour of the body, partly from the uncertainty whether the progeny of the purchased parents may turn out to expectation, and whether the return from the outlay of a considerable sum, for at least two or three years, may be equivalent to the risk; and partly from daily solicitude accompanying the progress of the young stock towards maturity, whether awakened by the risk of death, or the apprehension of receiving a remunerating price for stock, upon which the breeder is conscious he has bestowed every care and attention to bring to perfection. Were it not that the anticipation of success inspires him with hope, no man would undertake the toil of rearing live-stock; but the assurance that his efforts will place a fine description of stock in his possession, if he pursue a proper course of breeding, which will remunerate him in the end, supports and encourages him to perseverance. The success attending his efforts will, however, altogether depend upon his own exertions, and the course he has pursued.

An important and primary consideration in the rearing of live-stock consists in selecting animals of a size and disposition suited to the situation in which they are to be placed. To attempt any considerable improvement in the live-stock of a farm, care should be previously taken that there is a sufficient degree of shelter, shade, and warmth, as well as a high degree of fertility in the land. The circumstances which are to be more particularly considered in undertaking improvements in the nature of live-stock, especially in what relates to themselves, are those of the shape, the size, the disposition, the hardiness, the arriving quickly at maturity, the peculiar nature of the flesh, the property of fattening with expedition, the affording of milk in sufficient quantity, the quality of the hide, the fitness for performing labour, and the particular quality or nature of the breed, of whatever sort of animal it may be.

In the introduction of all sorts of live-stock upon a farm, the cultivator should constantly and carefully consider the nature and extent of his *keep*, as it is termed, or the means which he has of providing them with proper supplies of suitable food, as on this the size and other properties of the animals must, in a great measure, depend. The idea of good keep is necessary to be kept constantly in view, as without it little can be effected in this branch of husbandry. All good stock must be both bred with attention, and well fed; and these two essential requisites must always accompany each other. No matter how bleak or unforbidding the situation may be, a variety of stock may be selected for it; and this variety would be almost worthless in some of the richer situations. When beasts of a larger size are brought in than the quality of the food is calculated to support, they will degenerate apace, and never prove useful, until they come down to that standard or size adapted to their situation, and suited to their food. But when a smaller breed is brought in, the animals continue to increase in bulk until they arrive at that standard suited to their nourishment. There is, however, this difference between these cases, in respect to profit, that, in the former, the progress is retrograde, while, in the latter, the animals continue to improve till they arrive at that perfection which the change in their situation is calculated to produce.

The first step, then, towards the possession of an improved breed is to select such animals as are suited to the situation; and when the proper sorts have been introduced, the farmer should be extremely careful in the management of them, so as to keep them constantly in a thriving condition. Without due care in the management of the animals at all times, nothing can be expected but a signal failure, no matter what pains may have been previously taken in their selection.

A breed of animals may be said to be improved when some desirable property, which it did not previously possess, has been imparted to it, and also when its defects have been removed or diminished, and its valuable properties enhanced. Improvement, in its most extensive application to the live-stock of a country, may also be said to be effected when, by a total or partial change of animals, the value of the natural produce of the soil is augmented, and a greater quantity of human food and other desirable properties obtained from it. Whatever may be the merit of that skilful management which is necessary to the formation of a perfect breed, a considerable degree of the same kind of merit may be justly claimed by those who have introduced and established it in situations where its advantages had never been contemplated, and in which, indeed, the obstacles to its success might have appeared almost insurmountable.

To improve the form, rather than to enlarge the size, ought, in almost every case, to be the grand object of improvement. Size must ever be determined by the abundance or scarcity of food; and every attempt to enlarge it beyond that standard, must prove unsuccessful, and, for a time, become detrimental to the improvement of the animals, and prejudicial to the interests of their owners. It is certain that animals too large or too small will alike approach to that profitable size which is best adapted to their pastures;—the large animal becomes unhealthy, and degenerates in form, and in all its valuable properties; but the small one, while it increases in size, improves in every respect.

The size, form, and general properties of the inferior animals in a state of nature, may always be traced to the influence of soil and climate. Abundance of food, although of a coarse quality, will produce an enlargement of size in an animal which has previously been compelled to subsist on a scanty supply. Early maturity is also promoted by the same abundance; and, if the food is of better quality, and obtained without fatigue, a tendency to fatten at an early age will be gradually promoted, and combined with a tameness and docility of temper, a general improvement of form, and a diminished proportion of offal; but, at the same time, such animals will not be capable of enduring the fatigue and privations to which the less fortunate natives of mountain districts are habituated from their earliest age.

Hardiness of constitution is one of the most desirable properties of live-stock for districts producing only a scanty supply of food. A barren and mountainous surface and rigorous climate not only prohibit any considerable improvement in the quantity and quality of its produce, but, at the same time, prescribe to the cultivator the kind of stock which he must employ for the consumption of that produce. They must, indeed, be the creatures of his own mountains, and his own climate. He cannot avail himself of the scientific principles which have contributed so much to the improvement of the stock of richer pastures. His first object must be to select a drscription of stock capable of subsisting in the intended situation; and of two breeds equally hardy, he will, of course, select that which is calculated to yield the most profitable return.

Early maturity is a most valuable property in all sorts of live-stock. With regard to those animals which are fed for their carcasses, it is of peculiar importance that they should become fat at an early age, because they not only sooner make a return for the food consumed, but this return is also larger in proportion than that obtained from slow-feeding animals. A propensity to fatten at an early age is a sure proof that an animal will fatten speedily at any after-period of its life.

Tameness and docility of temper are desirable properties in most of the domestic animals. These are also, in some degree, incompatible with the character of the live-stock of mountain districts, merely because they are necessarily subjected to a very slight degree of domestication, and must search for their food over a greater extent of country. When they are reared in more favourable situations, plentifully supplied with food, and more frequently under the snperintendance of man, their native wildness is, in a great measure, subdued. The same treatment which induces early maturity will also effect this change.

The quality of the flesh, the proportion which the finer and coarser parts bear to each other, and the weight of both to that of the offal, constitute the comparative value of two animals of equal weight, destined for human food. The first of these properties seems to be determined by the breed and food, the second by the form and proportions of the animal, and the third by both these and its degree of fatness. The flesh of well-formed small animals, both of cattle and sheep, is well known to be finer grained, of a better flavour, more intermixed with fat, and to afford a richer gravy than that of large animals, and it brings a higher price accordingly in all the principal markets.

By the improvement of a breed, therefore, is to be understood the producing of such an alteration in shape and description as shall render the animal better fitted for the labours he has to perform; impart a greater tendency to become fat; or to produce milk or wool, or other particular qualities similar to these. The fundamental principle of this amelioration is the proper selection of parents. Peculiarity of form and constitution is found to be inherited by the offspring, and this is a most important but neglected consideration; for, however desirable, or even perfect, may have been the conformation of one of the parents, every good point may be neutralized or lost by the defective form of the other. In making selections, therefore, for the purpose of improving the species, such circumstances are to be attended to as the kind of progeny wished for, and the local situation where they are to be reared. In all cases, size and strength in proportion, combined with the greatest possible action and mildness of temper, especially in those intended for labour, are qualities indispensably requisite in both sire and dam, and the nearer they approach to each other in these respects, so much the better. The different varieties, it must be admitted, originally arose from one parent stock, but the influence of climate and other circumstances, have, in a succession of generations, combined to alter their form and size, and hence the origin of *breeds*. The animal economy is endowed with a power of accommodation, by which the individual constitution adapts itself to the situation in which it is placed. Nor is this law confined to the animal economy alone, for we find it pervading the entire face of nature, linking all together in one harmonious whole. It is, in fact, the capability of changes being effected by domestication that demands attention. If natural processes were uncontrollable by art, the influence of man would be of little avail. But when we find so much in his power, the greatest attention is necessary to give his efforts a proper direction.

Very different modes of practice have been pursued with regard to the improvement of live-stock, but they may, in general, be comprehended under some one of the three following theories, each of which has its respective admirers, by whom it is pertinaciously adhered to.

The first of these maintains the system of breeding from individuals of the same parentage, called the *in-and-in* system, as that alone calculated to effect a beneficial change in the production of live-stock. The second is in favour of breeding from individuals of two different offsprings or varieties, called the system of *cross-breeding;* and the third supports the principle of breeding from animals of the same variety, but of different parentage, which may be called *breeding-in-the-line*, or of the same race. None of these theories, however, is exclusively correct, at least as far as respects agricultural improvement; for, as will afterwards appear, the principles on which a selection for breeding depends, will lead occasionally to either mode.

The system of breeding *in-and-in*, or from individuals of the same stock, was much esteemed, in consequence of the great improvements effected by Bakewell and his followers. This gentleman founded his practice on the principle that *like produces like*, from which he inferred that by bringing together males and females possessing the same valuable properties he would secure their presence in the offspring, probably in an increased degree, they being inherited from both parents; and he concluded that by persisting in breeding from animals the produce of such selections, always keeping in view the properties which constitued their value, he should at length establish a *breed* of cattle, of which those properties would form a distinguishing and necessary characteristic. On the same principles all breeding to promote improvement must now be undertaken, and its progress will be accelerated or retarded in proportion as the practitioners possess or are deficient in the requisite degree of ability; for although the rule here stated may be truly said to be generally applicable, circumstances will often arise to render its judicious adaptation a matter of some difficulty.

On these principles Bakewell commenced operations which led to such brilliant results. The animals produced were unequalled for the early period at which they arrived at maturity, and their tendency to become fat—qualities which are deservedly esteemed by every one interested in the management of live-stock. They acquired an increased perfection of general symmetry, by which is to be understood a form not merely attractive to the eye of taste, but one in which the judgment acknowledged a considerable predominance of the valuable parts of the carcass over those of less value; an increased tendency to lay on flesh of a superior quality under all circumstances of feeding, and of course, a superior article for the use of the consumer, produced by a decreased consumption of food. Experience, however, soon convinced the admirers of this system, that there was a certain extent to which they could only carry their operations; for while the animals showed such a tendency to acquire flesh, and to arrive early at maturity, they, at the same time, lost much of their original hardiness of constitution, and manifested palpable signs of degeneracy.*

To remedy this, therefore, the system of *cross-breeding*, or selecting parents of different varieties of the species, was adopted. The importance of this plan as a means of improving existing varieties, and correcting the degeneracy consequent on a too strict adherence to the *in-and-in* system, seemed evident, and was accordingly extensively practised. Crossing was further supported by the opinion of those physiologists who had turned their attention to the cross impregnation of vegetables, with a view to the production of new and superior varieties of the various cultivated plants. Examples of the good effects of crossing may be found in the improved breeds of horses and swine in England. The great improvement in the breed of horses arose from crossing with the diminutive stallions, Barbs, and Arabians; and the introduction of Flemish mares was a source of improvement in the breed of cart-horses. The form of the swine has been greatly improved by crossing with the small Chinese boar.

But crossing the breed of animals may also be carried too far, and be attended with the production of a degenerate offspring. That much good has resulted from the practice of crossing cannot be doubted, yet it is obvious that it must require the nicest care and the greatest circumspection in order to suit the animals in the most exact manner to the nature of the intended improvement, otherwise injury, instead of advantage, may be the consequence. Indeed, from the injudicious and random method in which improvements in live-stock on this principle have, in general, been undertaken, it does not seem improbable but that injury instead of benefit may often have been produced by uniting such breeds as, from the great dissimilarity of their sizes, forms, and other qualities, could not have a chance of effecting the purpose contemplated. Examples of its bad effects are numerous. When it became the fashion, in London, to drive large bay horses, the surrounding farmers put their mares to much larger horses than usual; and this did infinite mischief to their breed, by producing a race of very inferior animals. Similar bad effects have been produced in the case of cattle and sheep. The system of crossing requires a great degree of judgment and experience. The bad qualities of the cross are too soon engrafted on the offspring of the original stock, and, once engrafted, they are not for many generations eradicated. The good points of both are occasionally neutralized to a most mortifying degree. Attempts to improve the animals of a country by any plan of crossing should, therefore, be made with the greatest caution; for, by a mistaken practice extensively pursued, irreparable mischief may be done. In any country where a particular race of animals has continued for centuries, it may be presumed that their constitution is adapted to the food and climate.

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* Mr. Bakewell commenced his operations for the improvement of cattle and sheep at Dishley, in Leicestershire, about the middle of the last century. The practice of this gentleman and his followers, furnishes an instance of the benefits of a division of labour in a department where it was little to be expected. After their stock had acquired that degree of celebrity which they so justly merited, the males were let out every year to breeders from all parts of England. By no other means could this new breed have spread so rapidly, nor have been made to accommodate itself so easily to a change of climate and pasture. The prices at which Bakewell's rams were hired appear enormous. In 1789, he received twelve hundred guineas for the hire of three brought at a birth.—*Encyclopædia Brittanica, Art. Agriculture.*

The pliancy of the animal economy is such that an animal will gradually accommodate itself to great vicissitudes in climate, and alterations of food, and by degrees undergo remarkable changes in constitution; but these changes can be effected only by degrees, and may often require a great number of successive generations for their accomplishment. But the system of crossing has for its object the effecting of this purpose in a comparatively short space of time. The greatest evil resulting from its application was the employment of males of too large a size, with a view of increasing the size of the progeny; being a fruitless attempt to counteract the laws of nature. No attempt to enlarge the size of animals, without a corresponding change in the quantity and quality of their food, will ever be successful.

It is a principle founded in physiological science, and countenanced by the test of observation and experience, that animals are somewhat endowed with the faculty of not only propagating an offspring that has, in a considerable degree, the properties, dispositions, and resemblance of themselves, but also of being, in some measure, subject to a similarity of disease. It would therefore appear that although there may be occasional deviations, the most certain method, and that which has the best foundation in the animal economy, is to breed in the same line, and, perhaps in the same family. By pursuing this plan the breeder may not only have the greatest security for attaining that improvement which he is anxious to produce, but run the least risk of deterioration. The success of this practice has not only been shown in the breeding of the farmer's stock, but also in that of the sportsman; it having been found that pointers and game-cocks have been bred with the greatest perfection and superiority by this mode, and that it is by the same means that the valuable properties of the race-horse have been perpetuated and preserved.

But the system of breeeing *in-and-in,* it has been seen, may be carried too far, and, in this case, is not calculated to produce an improved race of animals; nor are its defects to be remedied by adopting the very opposite extreme—a system no less prejudicial. While we are inclined to doubt the expediency of breeding from too close affinities, we are decidedly of opinion that too great a disparity between the sexes should be as carefully avoided; it being a well-ascertained fact that the greater the difference between the sire and the dam, the greater will be the uncertainty of the symmetry, feeding qualities, and general character of the offspring. The preferable plan, therefore, is to *breed in the same line*, that is, selecting animals of the same variety, avoiding equally the breeding from too close affinities, or from animals having few points of resemblance. Occasional crossings may be necessary to prevent degeneracy from too close affinities; but the farmer, once having secured the possession of a valuable stock, will admit a mixture of strange blood with the greatest caution.

A rule of universal application in the breeding of animals is, never to breed from parents having a tendency to the same defect, as, however trifling it may be in the first instance, it will become gradually more apparent, and soon interfere materially with the value of the stock. Although the most important consideration in breeding consists in the selection of males and females, intended to breed together, in reference to each other's merits and defects, yet it is not always by putting the best male to the best female that the best produce will be obtained; for should they both have a tendency to the same defect, although in ever so slight a degree, it will, in general, preponderate so much in the produce as to render it of little value. The smallest tendency to imperfection in the stock must be observed the moment it appears, in order that it may be counteracted before it becomes a serious blemish. This is to be effected by the introduction of a male of the same variety, having a tendency, in a slight degree, to the opposite defect.

The present improved stock of animals of the United Kingdom may be considered to be almost artificial productions, possessing qualities not found to the same extent in the wild animals of the same species. Thus the swiftness of the race-horse, the propensity to fatten in cattle, and the fine wool in sheep, are improvements which have been made in particular varieties of the species to which they belong. What has been effected by art must also be continued by the same means; for the most improved breeds will soon return to a state of nature, or perhaps defects will arise which were previously unknown, unless the greatest attention be paid to the selection of the individuals which are to breed together.

Regard should be had not only to the qualities apparent in animals intended for breeding, but also to those which have prevailed in the same race from which they are descended, as they will always show themselves sooner or later in the progeny. It is for this reason that we should not propagate from an animal, however excellent, unless we can ascertain it to be what is termed *well-bred*; that is, descended from a race of ancestors which have, through several generations, possessed the desired properties in a high degree. The offspring of some animals is also very unlike themselves; it is therefore a good precaution to try the young males with a few females, the quality of whose produce has been already ascertained.

These are the principles which should guide the breeder in the rearing and improving of his stock. The adoption of an opposite procedure will inevitably lead to disappointment and failure; because, being opposed to common sense, and the method which nature adopts in regulating the increase of the animal creation, it must necessarily fail. The practice of the experienced is a tolerably safe guide in regulating that of a beginner; but, were he merely to imitate the practice of others, his own could never rise above the standard followed. An essential requisite in a successful breeder is a thorough knowledge of the properties and characteristics of animals, technically termed *points*, for without this knowledge he will be ignorant in what the most desirable properties of his stock consists.

Abundant nourishment is necessary, to produce the most perfect-formed animal, from the earliest period of its existence until its growth is complete. The power to prepare the greatest quantity of nourishment from a given quantity of food depends on the size of the lungs, to which the organs of digestion are subservient. To obtain animals with large lungs, crossing the breed is the most expeditious method; because well-formed females may be selected from a variety of larger size, to be put to a well-formed male of a variety that is rather smaller. By such a mode of crossing, the lungs and heart become proportionably larger, in consequence of a peculiarity in the circulation of the fœtus, which contains a larger proportion of blood, under such circumstances, to be distributed to the lungs than to the other parts of the body; and hence arises that large and capacious chest which is produced by crossing with females that are larger than the males. The practice, according to the principle of improvement, may, however, be carried to such an extent that the bulk of the body might be so disproportionate to the size of the limbs, as to prevent the animal from moving about with facility. In animals in which activity is required, the practice should not be extended so far as in those intended for the food of man.

A facility in judging of the points characteristic of a good animal, and a readiness in deciding the comparative merits of different individuals, are qualities of great importance to those interested in the management of cattle. A good judge of cattle can, at once, form an opinion respecting their merits from observation, assisted by a slight touch of the fingers. Being familiar with the points characteristic of a perfect-formed animal, he can immediately decide as to the external form, and, by feeling the animal, he is aware whether it will readily take on fat or not, and in what part it will be the fattest. The sensation thus felt is different from that of softness, being mellow and kindly. This skill is only to be acquired by practice, and the feeling and scarcely be expressed in words. There are several other indications of a disposition to take on fat, which, though perhaps not strictly essential, are very generally found to accompany it, such as thin ears and hide, and fine and straight bones in the legs. Horns are to be chiefly regarded as a criterion for distinguishing one breed from another. A variety of minor circumstances are attended to by skilful breeders, in selecting animals for propagation, to which an inexperienced spectator would attach no importance whatever.

III.—REARING AND FEEDING OF LIVE-STOCK.

An endeavour has now been made to explain the principles upon which improvements in live-stock must be founded. To ensure success, we have seen that the breeder should possess an accurate knowledge of the structure of the animals, in order that he may be enabled to select those suitable for his purpose. But after having made the best possible selection of parents, and commenced his career on the strictest physiological principles, he must not imagine that his labours end here. On the contrary, the utmost care and attention are necessary in the management of the young stock from the period of their birth until they are finally disposed of.

Immediately after the birth of every animal, even of such as are domesticated, the rudiments of its education, as well as its bodily nourishment, are derived from its mother. In order that the latter purpose may be fully accomplished, the mother should, during pregnancy, have been duly protected against all extremes of temperature, well provided with shade and shelter, and abundantly supplied with food and water. When the period of gestation arrives, she should, in general, be separated from the rest of the herd, and, by whatever means the case may demand, rendered comfortable and tranquil.

After the birth, the first interference of man should be that of supplying the mother with food of a quality light and delicate compared with that which she had been in the habit of using. The gentlest treatment should be adopted, and the opportunity taken of familiarizing both parent and offspring with man, by gently caressing them, or at least by familiar treatment on the part of the attendant.

As the animals increase in size and strength, they should have abundance of air, exercise, and food, according to their natures; and whatever is attempted by man in the way of training or teaching, should be conducted on mild and conciliatory principles, rather than on those of harshness and compulsion. Caresses or familiar treatment should, generally, be accompanied by small supplies of food, at least at first, as an inducement to render the animal submissive to them; afterwards habit will, even in the inferior creation, render the familiarity of man agreeable to them for their own sakes, but even then, to keep up this feeding, small portions of select food should, occasionally, be employed as a reward. By contrasting this method with that of training or teaching by compulsion, the advantages to be derived from it will be evident.

Interest is the grand mover of the lower animals as well as of man. In taming by fear, all the interest which the animal has in obedience is the avoiding of evil—in taming by caresses and food, it is the attainment of enjoyment. The most extraordinary results are recorded as having been attained by the mild mode of treatment with almost every species of animals on which it has been tried; and to this may be advantageously joined, in the more powerful animals, hunger and fatigue. Complaints are frequently heard of the obduracy and vicious dispositions of the domestic animals, but it cannot be doubted for a moment that this proceeds entirely from the defective system of training and management adopted; for, when we hear instances of the most formidable animals of the desert being so much controlled by conciliatory treatment, as not only to admit the caresses of their keepers without danger, but also to yield implicit obedience to their commands, we are surely warranted in coming to the conclusion, that were similar treatment adopted in the management of the domestic animals, such a thing as a vicious and restive horse, or formidable ox or bull, would be altogether unknown.

Food ought always to be given in abundance, but it should never be supplied to satiety. Intervals of rest and exercise must be allowed according to circumstances. Even animals grazing on a rich pasture have been found to feed faster when removed from it once a day, and either folded or put into an inferior pasture for two or three hours. Stall-fed cattle and swine will have their flesh improved in flavour by being turned out into a yard or field once a day; and many find that they feed better and produce better flavoured meat when kept loose under warm sheds than when tied in their stalls. Coarse food may be first given to feeding animals, and as they acquire flesh, that which is of more solid and substantial quality. In general, it may be observed that, if the digestive powers of the animal are in a sound state, the more food is consumed the sooner will the desired result be obtained. A very moderate quantity beyond sufficiency constitutes abundance, but by withholding this additional quantity an animal, especially if young, may go on eating for several years without ever attaining to fatness.

In growing animals, the powers of digestion are so great, that they require a plentiful supply of food; but this may be, in general, coarser than that given at a more mature age. If rich food is supplied in liberal quantities, and exercise withheld, diseases are generated, the first of which may be excessive fatness; and growth is impeded by very rich food; for experience shows that the coarsest fed animals have always the largest bones. The prudent farmer will equally avoid the extremes of supplying food abounding in too much nutriment, or of giving food to animals in a great degree innutritious.

In order to derive the full benefit from food which it is capable of affording, it must be deprived of its vegetative properties before it enters the stomach. In the case of the stalks and foliage of vegetables, this is effected by mastication; but it requires some care to accomplish it in the case of grains. Hence the advantage of mixing corn given to horses or cattle with chaff or chopped hay or straw; and hence it is supposed that the inclination which fowls have to swallow small stones is intended by nature for the same object.

Experience confirms the propriety of giving salt to animals in small quantities, as it is found to increase the appetite, promote the secretion of bile, and to be generally favourable to health and activity. In this way only can it be considered as a preventative or cure for disease, unless, perhaps, in the case of worms, to which all saline and bitter substances are found to be injurious.

The degree of heat which is natural to animals in their original country, or has become so by habit, and the breeding for several successive generations in a cold climate, is necessary to their well-being; and a somewhat increased degree in the cold months, or diminished degree in such as are oppressively warm, is advantageous in the fattening process. When a sufficient degree of warmth to promote the ordinary circulation of the blood is not produced by the natural climate, or by exercise, it must be supplied by an artificial climate. Houses and sheds are the obvious resources both for this purpose and for protection from extremes of weather. Cold rains and northerly winds are highly injurious, by depriving the exterior surface of the body of caloric more rapidly than it can be supplied from within, by respiration and the action of the system; and also by contracting the pores of the skin so as to impede circulation. When an animal loses its natural covering, whether of hair, wool, or feathers, during an inclement season, the effects on its general health are highly injurious. The excessive heats of summer, by expanding all the pores of the animal frame, occasion a degree of lassitude and want of energy, even in the stomach and intestines; and, while the animal eats and digests less food than usual, a greater waste than usual takes place by perpsiration. Nature has provided trees, rocks, caverns, hills, and waters, to moderate these extremes of heat and cold, or, at least, to protect animals from them; and man imitates the example by the erection of houses, sheds, and other buildings, according to particular circumstances.

Good air and water it may be unnecessary to insist on as essential requisites for preserving animals in a healthy state; but cattle and horses, and even fowls, put up in close buildings, where there are no facilities for a change of atmosphere, often suffer on this account. A slight degree of fever is produced at first, and, after a time, when the habit of the animals becomes reconciled to such treatment, a retarded circulation and general decay or diminution of the vital energies take place.

Water for live-stock ought to be soft and pure, as being a better solvent than such as is hard, and containing mineral matters in solution. It ought to be of a moderate temperature, under that of the open air in hot weather, and exceeding it in winter. Deep wells afford this difference. In particular cases, as in those of animals in a suckling state, or milked, warm water has been found advantageous. Meals, or other light rich matters, are sometimes mixed with it; but it does not clearly appear, except in the last case, that liquid food is so generally advantageous for fattening animals as that which, being equally rich, is solid. Some judgment is requisite as to the time most proper for giving water to animals. In general, it does not appear necessary to supply it immediately after eating; for animals in a natural state, or pasturing in a field, usually lie down after filling themselves, and, after the process of digestion seems to have gone on for some time, they go in quest of water. Perhaps the immediate dilution of food, after being taken into the stomach, with water, may weaken the digestive powers by diluting the gastric juice. At all events, the free use of water at any time, but especially during meals, is found to weaken digestion in the human species. As animals of every kind become reconciled to any habit not ultimately injurious to health, perhaps, for those kept in houses, a stated quantity of water given an hour or an hour and a half after what may be called their meals, may be the best mode in which it can be supplied.

Moderate exercise ought never to be dispensed with, when the flavour of animal produce is any object. It is known to promote circulation, perspiration, and digestion, and, consequently, to invigorate the appetite. Care must be taken, however, not to carry exercise to that point when it becomes a labour instead of a recreation. In some cases, as in feeding swine and poultry, fatness is hastened by promoting sleep, and preventing motion rather than encouraging it; but such animals cannot be regarded as healthy fed; in fact, their fatness is rather the result of disease.

Tranquillity is an obvious requisite; for when the passions of the lower animals are called into action, by whatever means, their influence on their bodies is often as great as in the human species. Hence the use of castration, complete or partial separation, shading from too much light, protection from insects, dogs, and other annoying animals, and from the too frequent intrusion of man.

Cleanliness is favourable to health, by promoting perspiration and circulation. Animals in a wild state attend to this part of their economy themselves; but, in proportion as they are cultivated, or come under the dominion of man, this becomes out of their power; and, to insure their subserviency to his wishes, this part of culture, as well as others, must be supplied by art. Combing and brushing cattle, as well as horses, are known to contribute materially to health.

A good state of health will, in general, be the result of the mode of feeding and treatment now described. A part of the domestic animals, being cultivated as human food, are never allowed to arrive at the ordinary duration of life in the species, but are slaughtered at as early an age as they can be profitably disposed of for that purpose.

Every species of animal is, however, destined, in the absence of disease and accidents, to enjoy existence only for a particular period. In no species is this term absolutely limited, as we find some individuals outliving others by a considerable fraction of their whole lifetime. There is, indeed, little resemblance, in respect of longevity, between the different classes, or even species of animals; nor is there any peculiar structure by which long-lived species may be distinguished from those of shorter duration.

The circumstances which regulate the term of existence in different species, exhibit so many peculiarities, corresponding to each, that it is difficult to form any general observations on the subject. Health is precarious, and the origin of disease often involved in obscurity. The diseases to which the various species of live-stock are subject are numerous, and many of them are only incidental. They are also occasionally subject to accidents, especially wounds, inflicted by each other, or by brambles or stones in the attempt to go over fences. The proper treatment of this class of injuries is but imperfectly understood by the great number of those having the management of live-stock committed to their care. It is true that many of these are of so trifling a description, that nature is easily enabled to effect a cure; but there are others in which neglect or mismanagement is productive of the most injurious effects; and there are numerous instances of the losses sustained by the sacrifice of valuable animals from wounds, simple in themselves, but rendered fatal by the pernicious treatment adopted to effect a cure.

XVI.—THE HORSE.

I.—SPECIES AND VARIETIES.

The horse is by far the most important among the brute creation as a servant on man. Without this noble animal, it may indeed be asserted, that man could not have reached his present high state of civilization, nor have been able to overcome the numerous obstacles opposed to his comforts and happiness. He has long been domesticated and cultivated in most parts of the earth, for the various purposes of war, hunting, and draught.

Of the genus *Equus* there are several species enumerated by naturalists, the characters distinguishing which, though sufficient for the purpose of classification, are not, anatomically considered, of an essential or important nature. They are, for the most part, superficial, and consist in the comparative size of the ears, the length and texture of the hair, and the distribution of the external colours. Hence the most skilful comparative anatomist can scarcely distinguish a species of this genus merely from the inspection of a few isolated bones, although such inspection is amply sufficient for the determination of species in the case of almost any other animal of which we possess an osteological knowledge. Of the different species, those which have been domesticated in Europe are the

Equus caballus—The horse.
Equus assinus—The ass.

The horse, then, is the only species of the genus which interests us in this country as the subject of cultivation. The domestic breeds of the horse are numerous, and admit of such infinite variety, that a volume would scarcely suffice to contain their detailed records. The history of a wild animal is, in fact, confined to a few statements drawn from the observance of simple nature; but the history of a domesticated one is mingled with all the artificial devices used to tame and subdue his native wildness.

Climate has a great influence over the form of animals, and that form is found indigenous to each which best fits it for the purposes required of it. In the arid plains of the East, where herbage is scarce, a form is given which enables its brute inhabitants to transport themselves from one spot to another with facility; and as, in every situation, the flesh of the horse is eagerly sought after by the predatory tribes, so here, where these are peculiarly strong and active, the horse is formed peculiarly agile and swift to escape their attack, as well as peculiarly light, that his weight might not sink him in the sandy plains, nor his bulk retard him in his flight. Removed, however, to more temperate climes, where vegetation affords, by its luxuriance, more nutriment, and where the restrictions of danger have ceased to operate, he is no longer found thus small and slender; but with equal capacity for swift progression, we find him expanded into a form capable of keeping up that progression with a durability unknown to the original breeds from which he sprang. Symmetrically formed as we now see him, he at once evinces his claim to great speed. His bony skeleton exhibits a base, founded on the justest geometrical principles, presenting a series of lengthened bones acting, by means of a condensed muscular and tendinous organization of great power, on angles capable of great deflection and extension; while his pointed form fits him to cleave that atmosphere from which his deep chest enables him to draw, by extensive respirations, wind and vigour to continue his exertions. Purity of blood, by which is meant the result of confining to particular races or breeds the means of continuing the species, is observed with care and jealousy; and turf-jockeys assert, in this country, that they can discover a taint, or departure from this purity, through many succeeding generations.

With regard to the improvement which has been effected in our domestic races by the introduction of foreign blood, the first place is undoubtedly due to the Arabian. This animal is generally of a smaller size than the race-horse of this country—very easy and graceful in his motions, though rather leaner in his general aspect than we regard as consistent with perfect beauty. Having no other dwelling but a tent, the Arabian and his horse live upon the most equal terms; his wife and his family, his mare and her foal, generally lie indiscriminately together, whilst the children amuse themselves by caressing the animal, or climb about its body without fear. The Arab never beats his horse, and seldom makes use of the spur; he rather encourages him with friendly and affectionate words; and we may guess the result; for even more savage brutes confess the influence of kindness, and its superiority in subduing the temper, and in softening the asperities of a rugged nature, over harshness and constraint. The agility, as well as the power of endurance, of the Arabian horse is great; and when his rider happens to fall, he stops short in his most rapid career. It has been remarked, that instead of crossing the breed, as is so frequently done in this country, the Arabs take every precaution to keep it pure and unmixed; in fact, they preserve with the greatest care, and for an amazing length of time, the genealogies of their horses.*

To whatever object British enterprise is directed, the result is usually successful; and in no other department of useful industry has greater improvement been effected than in the production of superior breeds of horses. By unremittng attention to the breeding, and consummate skill in the training, the English *race-horse* is confessedly one of the finest, and certainly one of the swiftest animals in the world. The famous Flying Childers was calculated to move at the rate of eighty-two feet in a second, or nearly a mile in a minute; but this, of course, only for a very short time. An ordinary racer goes at the rate of a mile in less than two minutes.

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* "It is a mistaken belief that Arabia is very rich in horses. The breed of horses in that country is limited to the extent of its fertile pasturing districts, and it is in these parts only that breed prospers, while the Bedouins who are in possession of poor ground, seldom possess any horses. The Bedouins generally do not permit their mares to be covered until the completion of their fifth year; poor people who look anxiously forward to the profits to be derived from foaling, often have them covered after the completion of their fourth year. The price paid for the use of a stallion covering a mare is one Spanish dollar. The master of the horse has a right to waive the payment of the dollar, and may take his chance to wait until the mare foals; if she throws a filly he is entitled to a young female lamb of one year of age; if she brings a foal he is entitled to a similar male camel in payment of the use of his horse. When a horse is born, the Bedouins never let it drop down to the ground, but receive it upon their arms out of the womb of the mother, and keeping it for several hours upon their arms, occupied in washing it, in stretching and strengthening its limbs, and hugging it like a baby. After which they put it down and watch its feeble steps with particular attention, prognosticating from that movement the virtues or defects of their future companion."—*Burckhardt's Travels.*

The race-horse is no less characterized for his fleetness than by the ardour and spirit with which he performs his task. He enters into the spirit of the race with as much zeal as his rider, and will, in general, strain every nerve to outstrip every other. As he advances towards the starting-post, all his motions betray the eagerness of his desire to start. When the signal is given, away he springs at a settled and steady pace. The rider becomes, as it were, a part of the animal, whose every motion should correspond to his movements. He proceeds forward, restrained by his rider to the pace he thinks best suited to his strength, and preserving his powers to the last. The rider knows well when to push him; he touches him to indicate his wish for a trial of his powers; the hint is speedily taken, when all his nerves are called into action, and he bounds to his utmost stretch. It sometimes, though rarely, happens that the spur becomes necessary to rouse every energy; he knows its import, and every muscle is called into action to defeat, if possible, his competitors. If he has spirit, little application of these will be necessary, and, if dull, all the punishment that can be inflicted will prove unavailing. But, in general, the natural spirit of the race-horse, when roused into action from the opposition of the moment, has generally the effect of leading him through every obstacle, without any additional inducement to action. In regard to the origin of this breed, it may be stated as proceeding from an Arabian or Barbary stallion and an English mare already crossed with a Barb or Arab in the first degree, or the result of two crossings in the same degree. This is termed *first-blood*, being as near as possible to the foreign stock.

The *hunter* is derived from horses of entire blood, or such as are but little removed from it, uniting with mares of substance, correct form, and good action. In some instances, hunters are derived from large mares of the pure breed propagating with stallions of the old English road-horse. This favourite and valuable breed is a happy combination of the speed of the Arabian with the durability of the native horse. More extended in form, but framed on the same principles, he is able to carry considerable weight through heavy grounds with a swiftness equalled only by the animal he pursues, and with a perseverance astonishing to the natives of every other country. The hunter is, indeed, remarkable for what sportsmen call *bottom*, and is now very generally spread throughout the country, being frequently used, as soon as he has passed his prime, for more laborious purposes than his noble nature merits. He is employed in posting, and for the conveyance of public vehicles, and is greatly esteemed on the Continent, where he brings higher prices than any of the native breeds.

The farmer's horse is occasionally an animal of all work, being sometimes employed for the saddle, but principally engaged in draught. The horse for agricultural purposes should be of a middle size in preference to those of larger bulk, and consequently slower pace. It is not only in the harvest time that this superiority is apparent, but in the every-day work of the farm, the saving of time, and the saving of provender, which are effected. A horse of sufficient strength must, however, be chosen, and some blood will generally be desirable. In short, he should have sufficient weight to throw into the collar, and sufficient activity to go over the ground. An intermediate variety between the hunter and the heavier description of dray-horse is to be preferred.

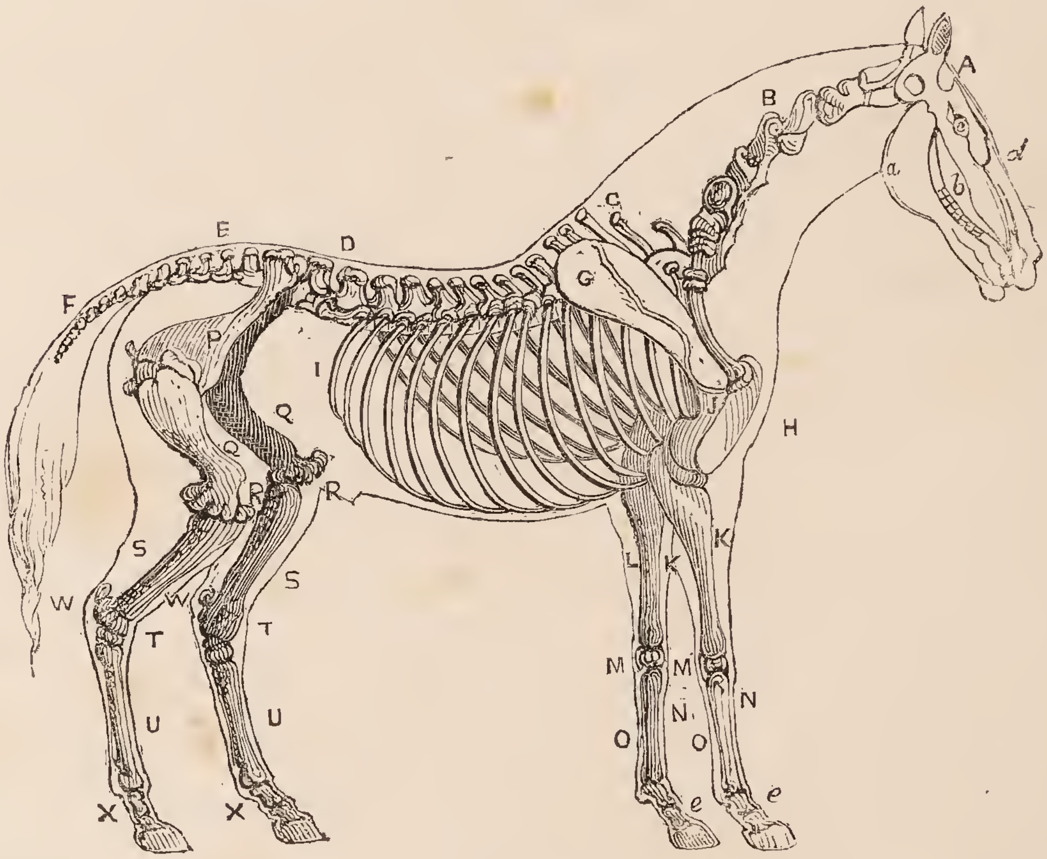
Superior attention has been paid to the rearing of horses for agricultural purposes in England, and the varieties of farm-horses were originally as numerous as the districts in which they were produced, each having its favourite breed. It is, however, much to be regretted that the same attention has not been paid in this country to the production of animals for similar purposes, the present race of Irish horses being generally of very inferior value.

In ascertaining the criteria of horses for general purposes, too much stress is usually laid upon what is termed *blood*, meaning such as are thorough bred, or allied to a foreign blood. But although it may be admitted that, for racing, it is an advantage that the animal should be thorough bred, we are not, on that account, to overlook and sacrifice the mechanical arrangement of the animal for other purposes, on account of the breed. How absurd it is to hear people extolling a half or three-parts bred horse because his sire was a particular horse, or because the dam was got by some other horse of celebrity; how foolish it is to be deceived by the qualities of one of the progenitors, if the animal himself is really defective. The principal reason for such attention to the pedigree of the animal seems to be, that the sire is famous for the goodness of his produce, and from this character it is inferred that all his future progeny will inherit the like properties.

II.—ANATOMY AND PHYSIOLOGY OF THE HORSE.

A just knowledge of the exterior conformation of the horse, in order to be able to form a correct judgment of the relative qualities of the animal, is an attainment of great value. It is not, however, to be acquired without much experience and patient investigation. To obtain a perfect knowledge of his form and structure, an examination of the osseous as well as the muscular system becomes necessary. The following figure represents the connexion of the principal bones of the horse.

Fig. 80.



A. The Head.
a. The posterior maxillary or jaw-bone.
b. The superior maxillary or upper-jaw.
c. The orbit or cavity in which the eye is contained.
d. The nasal bones.
B. The seven cervical vertebræ.
C. The eighteen dorsal vertebræ.
D. The six lumbar vertebræ.
E. The five sacral vertebræ.
F. The caudal vertebræ.
G. The scapula or shoulder blade.
H. The sternum, forepart of the chest, or breast bone.
I. The costa or ribs, seven or eight of which articulating with the sternum, are called true ribs, and the remaining ten or eleven which are united by cartilage are called false ribs.
K. The radius or bone of the fore-arm.
J. The humerus or bone of the arm.
L. The ulna or elbow.
M. M. The carpus or knee.
N. N. The metacarpal or shank bones

including the cannon and splint bones. *e.* the fore postern and foot.

O. O. The small metacarpal or splint bones.

P. The pelvis or haunch, consisting of three portions, the ilium, the ischium, and the pelvis.

Q. Q. The femur or thigh bones.

R. R. The patella placed on the stifle joint.

S. S. The tibia and fibula, also called the ham bones.

T. T. The bones of the tarsus or hock, six in number.

U. U. The metatarsals of the hind leg.

W. W. The os calcis, or point of the hock.

X. X. The sesamoid or fetlock bones.

The examination of the subject of organology and anatomy is conveniently arranged by dividing the different parts of the system into head, neck, trunk or body, and extremities or legs. The greater number of well-proportioned horses, with the exception of the head and neck, come within a quadrangle, the horizontal dimensions of which are usually between a twenty-fourth and twenty-eighth greater than the perpendicular. It must, however, be remembered, that with some considerable deviations from this form, many horses have proved of a very superior description; and that a deviation from these proportions appears, in some instances, as in that of the race-horse, not only favourable, but necessary also to his exertions. Nature will not be limited, and the perfection of her operations is not alone dependent on the arbitrary arrangement of parts, but on a harmony and accordance of the whole, internal as well as external. To the artist and amateur, such admeasurement may be convenient and useful, inasmuch as it will serve to guard against any glaring disproportion of parts, although it will not, by any means, invariably afford a safe and unerring guide.

The Head. The head of the horse is remarkable for its dimensions, formed by an elongation of the jaws; yet in him, as in most of the grazing tribes, its bulk is in an inverse proportion to the length of the neck, otherwise the muscles would not be able to lift it up. It is an important part, considered as relative to beauty alone, it being, in the inferior breeds, but little marked by grace or expression. Nothing can be conceived more dissimilar than the small, inexpressive features of the cart-horse, and the bold striking ones that grace the head of the blood-horse.

The head may be divided into two parts, the skull and the face. The bones which compose the skull, or cranium, are nine in number. They contain and protect the brain. They are separate in the foal at an early period of its existence; but soon after the birth, they are firmly united together by what anatomists call sutures; and so firm is the union, that a fracture will occur more readily in any other part than over a suture. At the period of the birth of the animal, they are connected together by cartilage, which yields to pressure, the edges of the bones in this case overlapping each other a little. This materially facilitates the birth, and contributes much to the safety of both the mother and foal.

The *frontal bones*, or those which protect the brain in front, being two in number, are placed immediately above the cavities of the eyes. Beneath these, and at the back of the eyes, is placed a considerable quantity of fatty matter, on which the eye revolves with little friction; but, in aged horses, and in diseases attended with general loss of condition, much of this fat dissappears; the eyes become sunken, and the pit above the eye deepens. From the depth of this cavity, therefore, an opinion may generally be formed regarding the age of the horse.

The cavity of the cranium may be said to be arched all round. The roof of the skull is composed of two plates of bones; the outer hard and tough, and the different parts dovetailed together, so as not to be easily fractured; the inner plate is elastic; and, by the union of these two substances, all vibration caused by the contact of external snbstances is destroyed. By means of the elasticity of the inner plate, the force or influence which might reach it through the outer, and, notwithstanding its difference of structure, affect it, is spread over the whole roof; and the inner plate is not dovetailed like the outer, because this conformation would impede the spread of the vibration.

Within this cavity is situated the *brain*, the centre of the nervous system. On an incision being made into the substance composing the brain, it appears to be composed of two substances different in structure, the *cerebrum* and the *cerebellum*. The cerebrum occupies the whole frontal, coronal, and a great part of the occipital portion of the skull. Its peripheral portion consists of cineritious matter; its centre of medullary, here and there mixed with cineritious. Its surface is marked by numerous furrows of various depths, which are convoluted in different directions. The composition of the cerebellum may be regarded as analogous to that of the cerebrum, the chief difference consisting in the former containing a somewhat larger proportion of cineritious matter, and being of a firmer consistence.

The nerves have their origin in the medullary portion of the brain, and they are concerned in the discharge of the various offices of life. They give motion to the limbs, they supply with energy the heart, the lungs, and every part of the animal frame. They proceed in different directions throughout the system; and, by their agency, the animal is enabled to receive impressions from surrounding objects, to connect himself with them, and to possess many pleasurable or painful sensations. One is spread over the membrane of the nose, and gives the sense of smell; another is expanded over the back of the eye, and the faculty of sight is gained; and a third goes to the internal structure of the ear, and the animal hears.

The spinal cord, or marrow, may be considered as a prolongation of the brain, or as connected with it for important purposes. It is enclosed in a hollow tube, extending through the bones of the neck and chine; and, as it passes along, it gives out branches on either side, which divide, and subdivide, and spread over every part of the frame. They are the nerves of sensation and voluntary motion. By means of them, the sense of feeling is extended over every part of the body; and the mind is rendered conscious of every external impression or change; the volitions or determinations of the mind are also conveyed to the different parts of the body, and the animal moves and acts as the will dictates.

The size, form, and situation of the *ears*, are minutely attended to by every one acquainted with the characteristics of the horse. Ears rather small than large, placed not too far apart, erect, and quick in motion, indicate both breeding and spirit: and if a horse is frequently in the habit of carrying one ear forward and the other backward, and especially if he do so on a journey, he will generally possess both spirit and continuance. The stretching of the ears in contrary directions shows that he is attentive to every thing that is taking place around him, and while he is doing this, he cannot be fatigued, or likely to soon become so. The ears are also indications of temper;

and a horse is seldom either playful or vicious but his ears are laid flat on the neck. A quick change in their position, and more particularly the expression of the eye at the time, will distinguish between playfulness and vice.

The *eye* is a most important organ, and comes next under consideration, as being enclosed in the bones of the skull. The eyes are deserving of particular attention, not only for their utility, but as objects of beauty and expression. In the blood-horse, the eye-sockets are more prominent and more inclined, by which the axes of vision diverge more from each other, than in those of the heavy breeds. By an examination of this organ, an opinion can generally be formed regarding the temper of the horse. A great display of white is generally dangerous, although, in same cases, the cornea, or transparent part, is naturally small; and, in this case, an unusually large portion of white must be seen. The eye is supported and covered in front by the lids, which, closing rapidly, protect it from danger, and supply it with that moisture which is necessary to preserve its transparency. In the momentary act of closing, they give a certain and sufficient respite to this delicate organ, which would otherwise be fatigued and worn out by the glare of the day; when the eye labours under inflammation, they defend it from the stimulus of light, and, gradually drooping, permit the animal to enjoy that repose which nature requires.

The cornea is, or should be, the only visible portion of the eye; for it must be remembered, that the exhibition of much white about it is a symptom of a vicious disposition or faulty conformation. The convexity of the cornea is a point of considerable importance. Its prominence certainly adds much to the beauty of the animal; but, considered as an organ of sight, a great degree of prominence is found to be injurious, as the rays of light, falling on the eye, are rendered too convergent, and the vision indistinct; or if the cornea be small and flat, the rays may not be convergent enough, and perfect vision destroyed; and, in either case, the horse may unpleasantly start, or suddenly and dangerously turn round.

There is no circumstance deserving of greater attention than the perfect transparency of the cornea over the whole of its surface. The eye should be examined both in front, and with the face of the examiner close to the cheek of the horse, under and behind the eye. The latter method of looking through the cornea is the most satisfactory, so far as the transparency of that part is concerned. During this examination, it is better that the horse should not be in the open air, and a good position for the detection of any blemish will be found to be standing in the door way of the stable, and a little within the door. Should any small, faint, whitish lines appear to cross the cornea, or spread over any part of it, they are assuredly the remains of former inflammation; or although the centre and bulk of the cornea should be perfectly clear, yet, if there should be a narrow ring of haziness around the edge of it, the conclusion is equally true, but the inflammation occurred at a more distant period. Whether, however, the inflammation has lately existed, or several weeks or months have elapsed since it was subdued, there is every probability that it will again recur at some future period.

The aperture in the centre of the eye, through which the light passes, is termed the pupil. It is oblong in shape, and is variable in size, according to the degree of light that falls upon it. In a dark stable, the pupil is expanded to admit a greater proportion of the light which falls upon the cornea; but when the horse is brought towards the door of the stable, and more light is thrown upon the eye, the pupil contracts, in order to keep out that extra quantity which would be painful to the animal, and injurious to the vision.

The organs of hearing and sight are situated convenient to each other, and individually exhibit a wonderful adaptation and arrangement of parts to the object in view. It is not less curious and interesting to observe how the vibrations of the atmosphere, constituting sound, are collected by the outer parts of the ear, and reflected on the tympanum by which they are conveyed to the brain,—than it is to examine the mode by which a representation of objects is conveyed through the different parts of the eye to the same organ, by which many of the most pleasing sensations are conveyed to man, as well as the lower animals.

We now proceed to a description of the *face* of the horse, so called in contradistinction from the upper part of the head, containing the brain. The nasal bones, or bones of the nose, are connected with the frontal bones above, and with the lachrymal and the bones of the jaw on either side; and are united together by a plain suture, which is a continuation of the frontal. They are rounded and arched above, because they are exposed to considerable violence and injury, which the arched form will enable them best to resist. These bones form a principal part of the face; and the length or shortness and character of the face depend on them. The length and size of these bones constitute the striking difference between the head of the cart-horse and of the blood-horse.

These bones form the roof of the important cavities of the nostrils, the delicate membranes lining which are the seat of smell. The extension of the nostrils at the lower part of these cavities is important, and intimately connected with breeding, courage and speed. The horse can breathe only through the nose, and all the air which goes to and returns from the lungs must pass through the nostrils. In the common act of breathing, these are sufficiently large; but when the animal is put to his speed, and the respiration is quickened, these passages must dilate or he will be much distressed. The expanded nostril is a striking feature in the blood-horse, especially when under the influence of excitement. In animals in which quick action is required, the nostrils should not only be large, but the skin and substance which cover the entrance into them should be thin and elastic, that they may more readily yield when the necessity of the animal requires a greater supply of air, and afterwards return to their natursl dimensions. Therefore nature, which adapts the animal to his situation and use, has given to the cart-horse, of whom quick action is seldom required, a confined nostril, surrounded by much cellular substance and a thick skin; and to the horse of more breeding, whose use consists in his speed and his continuance, a wider nostril, and surrounded by a much more flexible substance.

The *lips* are composed of muscles for the sake of strength, and of a multitude of small glands which secrete a fluid that covers the inside of the lips and the gums, in order to prevent friction, and likewise to furnish a portion of the moisture so necessary for the proper mastication of the food. The lips of the horse should be thin, if the beauty of the head be regarded, for if they are loaded with fat they cannot be so sensitive as they ought to be; but, although thin, they should evidently possess power, and be strongly and regularly closed. A firm compressed mouth gives a favourable and no deceptive idea of the muscular power of the animal. Lips apart from each other, and hanging down, indicate weakness or old age, or dulness and sluggishness.

The form of the mouth, as receiving the bit, is important. The depth of the mouth, or the distance from the forepart to the angle of the lips, should be considerable, whether beauty or utility is regarded. When shallow, it is not only inelegant, but the bridle will not be carried well, and the horse will hang heavy on the hand if there be not considerable depth of mouth. Within the mouth are situated the teeth, which are so placed as to have intercepted portions of jaw, both above and below, of considerable extent. These vacancies are called the *bars*, and are of extreme importance to the horseman, as it is by means of the agency of the bits resting on these parts, and operating on their sensibility, that he ensures obedience.

The bones in and giving form to the mouth are the superior maxillary, or upper jaw, containing the grinders; the anterior maxillary, or lower part of the upper jaw, containing the upper nippers or cutting-teeth; the palatine bone, and the posterior maxillary, or under jaw, containing all the under teeth.

Adhering to these bones, and forming the lining of the roof of the mouth, is the palate, composed of a firm, dense substance divided into various rugose folds. By means of these folds the food is retained within the mouth. The curtain of the palate, which is situated at the extremity of the palatine arch, is stretched directly across the hinder part of the mouth, and is not intercepted, as in man, by the pendulous body termed uvula. This palate-curtain is intended to shut up the communication between the mouth and the great cavity of the fauces, which it does at all times except when the horse is swallowing, at which period the curtain is forced back, and the food passes. From this cause, likewise, the horse is prevented from breathing by his nostrils; and when air does pass by the mouth, as in coughing, it is only effected by a forcible displacement of the curtain.

The jaws contain the *teeth*, which are the hardest and most compact part of the osseous system. There are usually forty of them in the horse, and thirty-six in the mare, the latter wanting the tushes. These, in the language of horsemen, consist of twelve nippers, four tushes, and twenty-four grinders, which numbers are equally divided between the two jaws. The teeth are inserted into indentations or sockets, between the bony plates of the jaw, by cone-like roots. The bodies of the teeth are principally composed of two substances, one of the nature of common bone, giving bulk and form, and the other of extreme hardness, which is called enamel, placed in man and carnivorous animals to give strength and durability; but in the horse, and other graminivorous animals, it is placed in the grinders in perpendicular plates, within the body of the teeth, by which contrivance a rough grinding surface is kept up; for the more bony parts wearing faster than the lamellæ of enamel, it follows that ridges remain to triturate the vegetable matter that passes between the teeth.

There are two sets of teeth, a temporaneous or milk set, and a permanent or adult set, in which wise provision man and most brutes participate. The milk set are some of them apparent at birth, there being usually six grinders in each side in the young foal, which number is never increased. The nippers begin to appear soon after birth, and follow a regular order of succession until the animal is three or four months old; at which time he begins to acquire support from herbage as well as milk. The centre nippers first make their appearance, and will have attained their natural level in about two months, and the second pair will also be considerably advanced. Between the second and third month the second pair will have overtaken those which first appeared. They will then begin to wear a little, and the outer edge, which was at first somewhat raised and rough, is brought to a level with the inner edge; and so the mouth continues until some time between the sixth and ninth month, when another nipper begins to appear on each side, making six above and six below, and completing the colt's mouth. After this, the only observable difference until between the second and third year is in the wear of the teeth. These are technically called the foal teeth.

These teeth are sufficient to supply the wants of the animal during the early period of his growth. They are sufficiently large to fill and occupy the jaws; but, when the jaws become expanded with the increasing growth of the animal, the teeth are separated too far to be useful, and another and larger set is required. Evident provision is made for them, even before the colt is foaled. In cavities in the jaw, beneath the first or temporary teeth, are to be seen the rudiments of a second and permanent set. These gradually increase, and, pressing upon the fangs or roots of the first teeth, displace them, and occupy their place. This change of teeth commences in those which earliest appeared, and therefore the two front grinders give way at the age of two years, and are succeeded by larger and permanent teeth.

A horse, at three years old, ought to have the central permanent nippers growing, the other two pairs waisting, six grinders in each jaw above and below, the first molars level with the others, and the sixth protruding. At three years and a half, or between that and four, the next pair of nippers will be changed, and the mouth at that time cannot be mistaken. The central nippers will have attained nearly their full growth; a vacuity will be left where the second stood, and the corner ones will be diminished in breadth, and worn down. At this period, also, the second pair of grinders will be shed. At four years, the centre nippers will be fully developed. The corner nippers will be larger than the inside ones, yet smaller than they were. The sixth grinder will have risen to a level with the others, and the tushes begin to appear.

The tushes are four in number, two in each jaw situated between the nippers and grinders, much nearer to the former than the latter, and nearer in the lower jaw than in the upper; but this distance increasing, in both jaws, with the age of the animal. At the age of which we are now speaking, the tushes are almost peculiar to the horse, and castration does not appear to prevent or retard their development. All mares, however, have the beginnings of them in the chambers of the jaw, and they appear externally in the majority of old mares.

At four years and a half, or between that and five, the last important change takes place in the mouth of the horse. The corner nippers are shed, and the permanent ones begin to appear; the central nippers are considerably worn, and the next pair are beginning to show marks of usage. The tush has now protruded, and is generally a full half-inch in height; externally it has a rounded prominence, with a groove on either side, and, within, it is evidently hollowed. It is from the rising of the corner nipper that the animal changes the name—the colt becomes a horse, and the filly a mare.

At six years the centre nippers are considerably worn down, and the concavity, or mark, is worn out. There will still, however, be a difference of colour in the centre of the tooth by the substance composing it, which consists of bony matter, being of a deeper colour than the enamel by which it is surrounded. In the next incisors the mark is broader, shorter, and fainter; and in the corner teeth the edges of the enamel are more regular, and the surface is evidently worn. The tush has attained its full growth, being nearly or quite an inch in length, convex outward, concave within, tending to a point, and the extremity somewhat curved. The third grinder is fairly up, and all the grinders are level. Now, or perhaps at a period of six months before, the horse may be said to have a perfect mouth. After this period, the only criterea of age are the general state of the mouth and the appearance of the animal.

The Neck. The exterior parts which compose the neck are, first, the upper surface, which is furnished throughout its whole extent with an elegant assemblage of hair called the mane. In some instances, as in stallions, the mane is of enormous length and thickness. In dark-coloured horses it is commonly black, bnt in horses of colours approaching to a lighter hue, the reverse is frequently seen, and the mane and tail of these are often lighter than the body.

The upper surface of the neck should form a moderate but elegant curve, which is greatly favourable to beauty. The under surface should be nearly straight, and no part should much abound in flesh, as this is generally a criterion of a sluggish disposition. The length of the neck is also deserving of attention. When it is too long, the head must of course gravitate by the increased length of the arm of the balance; it likewise seldom presents a firm and proper resistance to the bridle. When, on the contrary, the neck is too short, the head is frequently ill placed, and the horse will have an ungraceful appearance.

The neck of the horse, in common with that of most animals belonging to the class mammalia, is composed of seven bones called vertebræ, moveable or turning upon each other. They are connected together by strong ligaments, and form so many distinct joints, in order to give sufficiently extensive motion to this important part of the animal. The bone nearest to the skull is called the atlas, because in the human body it supports the head; the second is the dentata, having a process like a tooth by which it forms a joint with the first bone; and the remaining bones of the neck are called the rack-bones, and are of a strangely irregular shape, though bearing considerable resemblance to each other. Through these bones a perforation is placed for the passage of the spinal marrow, and they terminate like a wedge on the top for the attachment of the ligament of the neck, and irregular plates or processes from the sides for the attachment of the muscles. At the upper end of each is a round head or ball, and at the lower end a cavity or cup; and the head of the one being received into the cavity of the other, they are thus united together and securely fixed by ligaments in their proper position, so that dislocation can rarely take place, which would be the immediate death of the animal. These bones, with their attending ligaments, serve as a frame-work, to which are attached numerous muscles giving motion to the head, and supporting it without any exertion on the part of the animal.

In the forepart of the throat is situated the *windpipe*, designed for the conveyance of air to and from the lungs. It is composed of alternate rings of membrane and segments of cartilage, rendering it at once flexible and cylindrically hollow. The windpipe should project from the neck, and appear as if it were detached, for two important reasons; first, that it may easily enter between the channel of the jaws, so that the horse may be reined up without suffering inconvenience; and next, that, being more loosely attached to the neck, it may more readily adapt itself to the changes required, than if it were enveloped by fat or muscle, to a certain degree unyielding. This degree of prominence is less essential in the cart-horse than in those of which quick action is required.

Another important organ, extending along the whole length of the neck, is the *œsophagus*, or gullet, reaching from the back part of the mouth to the stomach, and serving to convey the food from the one to the other. At the top of the neck, it is immediately behind the windpipe, but it soon inclines to the left. Having entered the chest, between the first two ribs, the gullet passes along the upper part of it, and then, piercing the diaphragm, enters the stomach. It is composed of different coats of cellular, muscular, and membranous substance, in order to render it capable of expansion and contraction, by which the food is more readily conveyed to the stomach.

The Trunk or Body. The bony column called the *spine* is divided by anatomists, for the sake of distinction, into several parts, each containing a certain number of joints. The part adjoining the head has been seen to consist of seven of these, which are called the *cer-*

vical vertebræ. That composing the back, and extending from the neck to the haunch, consists of twenty-three bones, eighteen of which are termed the *dorsal vertebræ*, and five the *lumbar vertebræ*, occupying the loins. On this part of the animal the weight or burden is laid; and there are two principal things to be observed, easiness of carriage and strength. The former of these is effected by the spine being composed of a number of joints, instead of one inflexible mass of bone; and the latter is also secured by the mode in which these bones are joined, and the strength and elasticity of the ligaments which bind them together.

The length of the back is an important consideration. A long-backed horse will be easy in his paces, because the increased distance between his fore and hind legs, which are the supports of the spine, will afford greater room for the play of the joints of the back; but what is thus gained in elasticity is lost in strength. To secure great speed, a long back is always necessary; but, for general purposes, the short-backed horse is to be preferred. He will possess health and strength; for horses of this make are proverbially hardy. He will have sufficient ease not to fatigue the rider, and speed for every ordinary purpose. The back should be depressed a little, immediately behind the withers, and then continue in almost a straight line to the loins. This is the form most consistent with beauty and strength. Some horses have a very considerable hollow behind the withers, and they are then said to be *saddle-backed*, as it seems as if a depression was particularly made for the saddle. Such horses are evidently easy goers, for this curve inward must necessarily increase the play of the joints of the back; but, in the same proportion, they must be weak and liable to sprains.

The *loins* may be considered as the part which extends from immediately behind the hinder part of the saddle, when properly placed, to the rump. The width of the loins is of considerable importance, as regarding the strength of the animal, for when large it affords a greater surface for the attachment of the powerful muscles of the back and loins. The union of the back and loins should be carefully remarked. There is sometimes a depression between them—a kind of line as it were, drawn across, which shows imperfection in the construction of the spine, and is regarded as an indication of weakness.

The *withers* are formed by the long transverse processes of the dorsal vertebræ, and as their use is to serve as levers to muscles, so their length, characterized by the height of the withers, must be of advantage. Commencing at the junction of the cervical and dorsal vertebræ, the second joint of the latter is lengthened, and inclined backward; the third and fourth increase in length, and the fifth is the longest; they then gradually shorten to the twelfth or thirteenth, which becomes level with the bones of the loins.

High withers are generally associated with good action and great speed. When the withers are high, or the fore-hand well up, as it is termed, it is favourable to celerity and safety of action; but as these properties are less wanting in the heavy breeds, there is a considerable variation of form in this respect. The utility of the cart-horse chiefly depends on his power of depressing the fore-quarters, and throwing their weight fully into the collar; but, in general, it is advisable that the horse for all work should have high and well-formed withers.

The *chest* of the horse is unlike that of the human body, becoming narrower towards the lower part, and terminating like the keel of a ship, a form more favourable to the flexion and extension of the fore-legs, as well as of the shoulder blades, than any other. It is formed by the spine, the ribs, and the sternum, or breast-bone. The chest is a distinct cavity, being separated from the abdomen or belly, by a muscular partition, called the diaphragm. It contains the heart and the lungs;—the one employed in circulating the blood, and the other in restoring to it the power of supporting life; and on the size and soundness of these organs, the health and the strength of the animal principally depend. A moderate breadth, with depth at the girth, and a swelling out, or barrelling, as it is termed, behind the elbow, will be the most desirable form. The heavy cart-horse, whose power of draught is proportionate to the weight which he can throw into the collar, requires the broad chest, not only that his weight may be thrown more before, but that, by the increased capacity of his chest, he may obtain that bulk and size which will enable him to press with the requisite force upon the collar.

The next point of consequence regarding the capacity of the chest is the length or shortness of the carcass, or the extent of the ribs from the elbow backwards. This depends on the purposes for which the horse is intended. If speed be required, there must be full room for the action of the hinder limbs, and, consequently, a large extent of what is termed flank. When this part is, however, too large, it indicates weakness; because it is usually the consequence of too long a back; and such a horse is said to be not well-ribbed-up.

The chest, it has been said, contains the heart—the great agent of circulation, the action of which is altogether involuntary, and independent of the will; for, were it otherwise, man and the lower animals might cease to live at their own discretion. The blood, after having traversed the system and nourished it, is conveyed to the heart, by which it is propelled to the lungs, to be afterwards again conveyed to the different parts of the frame. The organs by which these operations are carried on are the arteries and the veins, the former serving to carry the blood through the body, after having been purified by coming into contact with the air, and the latter to convey it back again to undergo the same process.

The arteries are composed of three coats, the external, or elastic, the middle, which is muscular, and the internal, which is membranous, being the mere lining of the tube. The elastic coat is that by which these organs are enabled to yield to the gush of blood, and enlarge their dimensions as it is forced along them, and by which they also contract again as soon as the gush of blood has passed. The arteries have their origin in the left ventricle, or lobe, of the heart, and are extended by various ramifications throughout the system, diminishing in size as the distance from the heart increases, until they terminate by imperceptibly small tubes over the whole surface of the body. They pour out the perspiration on the skin, and, in the different cavities of the frame, they yield the moisture which prevents friction. In other parts they terminate in glands, in which a fluid, essentially different from the blood, is secreted.

The elasticity of the arteries, and their yielding to the gush of blood passing through them, constitute the pulse, which is of such essential service, both to the human practitioner, and the veterinary surgeon, in ascertaining the state of their respective patients. The number of pulsations in an artery will give the number of the beatings of the heart, and so express the irritation of that organ, and of the frame generally. In a state of health, the heart beats, in the cart-horse, about thirty-six times in a minute, and in the smaller and thorough-bred horses, the pulsations are forty or forty-two. This is said to be the standard pulse,—the pulse of health; but it varies singularly in different circumstances, even when nothing can be said to be materially wrong. The beatings of the pulse may be found in several places; but the most convenient is, perhaps, at the lower jaw, where the submaxillary artery comes from under the jaw.

The arteries, then, serve to carry the blood through the body, but, after it has fulfilled the necessary functions, it is again to be conducted back to the heart, and this is accomplished by the veins. They have but two coats, a muscular and a membranous, both of which are thin and comparatively weak. They are more numerous and much larger than the arteries, and, consequently, the blood, lessened in quantity by the various secretions separated from it, flows more slowly through them. It is forced on its course chiefly by the impulse at first communicated to it; partly, in the extremities and external portions of the frame, by the pressure of the muscles: and, in the cavity of the chest, its motion is assisted, or principally caused, by the sudden opening of the ventricles of the heart, after they have closed upon, and driven out their contents, and thereby causing a vacuum which the blood rushes on to fill. The veins contain a curious valvular structure, which is admirably adapted for preventing the blood from taking a retrogade course.

The operation of blood-letting, so important in pathology, is performed by making an incision into the veins, being thence called *venesection.* The veins are selected in preference to the arteries, for the purpose of blood-letting, because they are more superficial and larger, and blood can be more easily and certainly drawn from them, the flow of blood being, at the same time, more easily stopped.

The chest likewise contains the *lungs.* They are spongy masses, divided into right and left, with less divisions, called lobes. The right lung is larger than the left, because the heart, inclining to the left, leaves less room on that side of the chest. Where the windpipe enters the chest, it divides into two parts, one going to each lung; and when these reach the substance of the lungs, they separate into innumerable branches, each terminating in a bag or cell.

The office of the lungs may be shortly stated. In passing through the body, the blood becomes essentially changed in its nature, having given out its vital principles of heat to the mass, and vitality to the muscular fibre, besides having several important secretions taken from it. Having given out these principles, it is returned by the veins, and is pressed forwards into the lungs, circulating throughout their substance, and imbibing, by their contiguity or continuity with the air vessels, oxygen gas from the atmospheric air contained in them. In return for the oxyen received, carbon is given out, which passes off in the form of vapour. As the blood is renovated, so the air it acted on is deteriorated, and is, therefore, expelled from the chest to make room for a fresh inhalation, to oxygenate a fresh quantity of blood, and thus to renovate afresh the vital powers subservient to its influence. The process of respiration is, therefore, performed by alternate expansions and contractions of the chest, inhaling and exhaling repeated portions of air, from the period of the birth of the animal, until the cessation of the vital powers.

The chest, it has been said, is separated from the abdomen, or belly, by the diaphragm, which extends obliquely from the loins to the breast bone. In a state of rest, the diaphragm is convex, or projecting slightly forward towards the lungs, and concave, or hollow, backward towards the stomach and intestines; but at each respiration these appearances are nearly reversed. On the side towards the chest, it is covered by the membrane which invests the lungs, and towards the belly, by that which covers the intestines. It is attached to the spine, and ribs, and the breast-bone, by tendinous or fleshy expansions, and in the centre it is composed of strong muscular fibre. The gullet passes through the diaphragm on its way to the stomach.

The horse has one stomach only, and that a very small one, drawing a very wide line of separation by this means between his family and that of the ruminants. It is found on the left side of the belly, lying upon the large intestines, its forepart close to the liver, and its left side in contact with the diaphragm. Being situated so near the diaphragm, or great breathing muscle, the injurious effects of an overloaded stomach, as obstructing respiration, are easily understood. It is composed of a number of muscular coats, through the agency of which the process of digestion is performed. On the entrance of food into the stomach, a peculiar juice is secreted from its folds, which, aided by the muscular action of the organ itself, acts as a solvent, and speedily secured the food to a soft pultaceous mass.

This is further resolved into matter called chyle, which is conveyed into the circulating system, and refuse, or excrement, which is conveyed through the intestinal canal, by which it is ejected from the body.

The intestines of the horse cannot be regarded in the same manner as those of ruminating animals, or such as have the process of digestion finished before the food leaves the stomach. In the horse, the stomach is small, compared with the size of the animal, and his exertions requiring that he should eat largely, the process of digestion is not altogether in the stomach. Before leaving the stomach, however, the food is converted into a substance called chyme, in which state it passes into the small intestines, there to be resolved into chyle and excrement, as has been already stated.

Between the stomach and diaphragm is situated the *liver*, its right lobe being in contact with the diaphragm and the right kidney, and the middle and left divisions with the stomach. It may also be considered as a digestive organ, inasmuch as it secretes a fluid whose office appears to be to quicken the intestines. It has been seen, that the blood which has been conveyed to the different parts of the body by the arteries is carried back to the heart by the veins; but that which is returned from the stomach, intestines and spleen, instead of flowing directly to the heart, passes first through the liver. In traversing this organ, a fluid is separated from the blood, called the bile. This is probably a kind of excrement, the continuance of which in the blood would be injurious; but while this is thrown off, another important purpose is answered,—the process of digestion is promoted; and, particularly, from the bile changing the nutritious part of the food from chyme into chyle, and separating it from that which, containing little or no nutriment, is voided as excrement.

The kidneys are two excremental glands, situated within the lumbar region. Through their instrumentality, the urine is separated from the blood, and conveyed into the bladder, from which it is occasionally voided. The kidneys of the horse are more easily stimulated into increased action by diuretics than those of most other animals. There appears to be a sympathy between the kidneys and the skin, as when perspiration is copious and abundant, the discharge from the urinary canal is inconsiderable.

The Extremities or Legs. The extremities of the horse come now to be considered. They are those parts of the frame most essentially connected with the action and value of horses, and most annoyingly the subjects of disease. The extremities contain the whole apparatus of motion, and it is with the action and strength and speed of the horse that we are most concerned. Commencing then with the fore-legs, the mode of junction with the body comes first to described.

The *scapula*, or *shoulder-blade*, connects the fore-legwith the body. It is broad, flat, and rather triangular bone, situated forward on the side of the chest. Its superior surface is furnished with a considerable cartilage, by means of which its surface is augmented without weight, and the posterior ends in a superficial cavity which receives the head of the humerus, or arm-bone. It is divided externally into two unequal portions by a ridge or spine recurring through almost the whole of its extent, and designed for the attachment of important muscles. The broad or upper part, having no muscles of any consequence attached to it, is terminated by cartilage.

The situation and direction of the shoulder-blade are deserving of attention. The centre of action in the shoulders is their common centre, and the extent of action of any part moving on its centre, is dependent on the length of such part ; the motion the shoulder enjoys is confined to the perpendicular backwards, and to as great an elevation of the muscles as they will admit of, forwards. It will be therefore evident, that the more oblique the situation of the shoulder-blade the greater number of degrees it can go through ; it must be evident, also, that when the shoulder-blade is long and deep, as well as oblique, this advantage is increased. A shoulder having a considerable degree of inclination backward towards the top, then appears to be that which is to be preferred. In certain cases, however, this conformation, instead of adding to the value of the animal, is rather to be regarded as a defect. It is essential in all horses in which speed is desirable, but for the purpose of heavy draught it is not found advantageous. In the latter case an upright shoulder is to be desired, because its additional thickness gives additional weight to throw into the collar, which the power of the hinder quarters is fully able to accomplish ; and the upright position of the shoulder also gives that direction to the collar which enables the horse to act upon every part of it, and that inclination of the traces which will enable his weight or power to be advantageously employed.

Forming a joint with the shoulder-blade is the *humerus* or lower bone of the shoulder. It is a short, strong bone, slanting forward in an opposite direction to the shoulder-blade. Connected with it is the *fore-arm*, extending from the elbow, or lower part of the humerus, to the knee, and consisting, in the young horse, of two distinct bones. The front bone, called the *radius*, is nearly straight, receiving into its upper end the lower extremity of the humerus. The hinder bone is called the *ulna*. These bones are united together by cartilage and ligament, and before the horse becomes old, the whole of the arm consists of one bone only.

The *knee* constitutes the joint or joints between the arm and shank or leg. It is composed of seven bones, whose principal uses appear to be to extend the surface of attachment of ligaments and tendons, and, by their interruptions, to lessen the shocks of progression. The ends of all bones are covered with elastic cartilage to prevent them from injury by concussion, and in addition to this the bones of the knee are covered above and below by a thick coating of cartilage, connected together by strong ligaments, but separated by fluids and membranes interposed. The concussion is thus spread over the whole of them, and by the peculiarity of their connexion rendered harmless.

There is perhaps no part of the horse more strictly scrutinized by a purchaser than the knee. As a criterion of safe going, it should be particularly examined to ascertain that the skin has not been broken by falls, a circumstance which materially affects the value of the horse. More dependence is, however, to be placed on the conformation of the fore-extremities generally, than on the absence or presence of a scar on the knee. But a broken knee is always a suspicious circumstance, and call for the most careful observation of the make and action of the animal. If it be accompanied by a thick and upright shoulder, and legs far under the horse, and low slovenly action, the broken knee is just evidence of a faulty conformation. But if the shoulders be oblique and the withers high, and the fore-arm strong, the animal is not to be rejected for a scar on the knee, which might occur with the safest-going horse, either in the dark, or through the mismanagement of an unskilful rider.

The *leg*, or that part of the limb between the knee and the fetlock, consists of three bones—a large one before, called the *cannon* or shank, and two smaller or *splint bones* behind. The former of these is the straightest of the long bones, and the most superficially situated, is some parts being merely covered with the skin. The small bones are united to the cannon by the same sort of substance which is found in the colt between the bone of the elbow and the main bone of the arm. They reach from one-half to two-thirds of the length of the shank-bone, and through their whole extent are united to it by this substance.

It is of importance to ascertain that this part of the horse be light, straight, and strong. Much stress is deservedly laid on the necessity of this part being wide when viewed laterally. Viewed in front, its being thin is favourable ; because, being made up principally of bone and tendon, any addition to it beyond these must arise from useless cellular matter, or otherwise from matter worse than useless, being placed there by disease. Any thickening of the part generally or partially should be looked on with suspicion, as, if natural, likely to interfere with motion without adding to strength ; or, if accidental, as a mark of acquired injury likely to remain. The back sinews of the part should not only be large and firm, but they should, like the limb generally, be very distinct from the knee to the fetlock ; in this course, if any thickening be observed, it betokens former injury, or extension or interruption of ligamentous fibres which usually have a disposition to recurring weakness.

The *pastern* joins the foot and the shank just described. The conformation of this part is admirably adapted to fulfil the important offices which it has to perform, and being complicated in structure it is extremely liable to injury and disease. The joint connecting the cannon and pastern is called the *fetlock joint*, and the term fetlock is also applied to the back portion of the pastern which is usually covered with long hair. The bones of the pastern serve to act not only as a spring to prevent concussion, but to throw the tendon of the foot which runs over them farther from the centre of motion. The pastern bone is situated obliquely forward, and on this obliquity depend the ease and elasticity of the motion of the animal ; nevertheless, when it is too long, it requires great effort in the tendons and ligaments to preserve it in this situation, and thus long-jointed horses must be more subject to fatigue and to strains than others.

The length and obliquity of the pastern must vary according to the purposes for which the horse is intended. Swiftness and easiness of pace are generally concomitants of long and slanting pasterns, but they are altogether unsuited for the purpose of heavy draught. The very circumstance which enables the dray-horse to throw so much weight into the collar, throws the riding-horse down, and renders him unsafe.

On a review of the conformation of the fore-extremities, it may be remarked, that, viewed anteriorly, they should be widest at the chest, and should gradually approach to each other towards the fetlocks. The degree of width must depend on the size of the horse, and the purpose for which he is wanted. The legs of the draught-horse can scarcely be too far apart. His rounded chest enables him to throw more weight into the collar; and being seldom, if ever, required for speed, he wants not that occasionally increased expansion of chest which the circular form is not calculated to give. The hunter and hackney must have sufficient expansion of chest, and the legs sufficiently wide apart to leave room for the play of the lungs; but depth, more than roundness of chest, is here required, because the deep chest admits of more expansion when the horse is in rapid action; yet, if the breast be too wide, there will be considerable weight thrown before, and the horse will be heavy in the hand, and unsafe.

Whether the legs are near to each other or wide apart, they should be straight. The elbow should not have the slightest inclination inwards or outwards. If it incline towards the ribs, its action will be confined, and the leg will be thrown outward when in motion, and describe a curious and awkward course; and this will give a peculiar rolling motion, unpleasant to the rider and unsafe to the animal. The toe will likewise be turned outward, which will not only prevent the foot from coming flat on the ground in its descent, but be usually accompanied by cutting. If the elbow is turned outward, it is attended by like injurious effects. The weight, in either case, cannot be perfectly distributed over the foot.

Viewed laterally, the fore-limbs should stand in a perpendicular position from the shoulders downwards, and the toe should be placed perpendicularly under the point of the shoulder, as it is called. If the foot should stand beyond this, the action will be confined; and when it stands behind the perpendicular line, the defect is considerable, by the removal of the centre of gravity too much forward, by which an increased tendency to stumble and fall is entailed; and as this, in general, accompanies a want of extent and obliquity in the shoulder, so it likewise lessens the speed.

The *posterior extremities* differ much from the anterior, not only in their superior strength, and in the different lengths and directions of the parts, but also, in some degree, in their uses.

A very important characteristic of the breed of the horse is the situation of the haunch-bone, the peculiar conformation and direction of which serve to distinguish the blood-horse from the draught-horse. In the former, the line from the setting on of the tail to the loins is nearly straight, or at least very little curved, the effect of which is the placing of the haunch-bone in a more slanting direction—a direction in which, as has been stated in treating of the fore-legs, the muscles act with most advantage. If the bones behind the loins, which form the continuation of the spine, took a somewhat arched form, as they do in the cart-horse, it is evident that the haunch-bone must be more upright, and, as a consequence, the thigh-bone would also be more upright, by which the speed of the animal would be greatly impaired.

The *femur*, or thigh-bone, joins the haunch, and it is the largest of the body; its vast indentations and risings, almost peculiar to itself, show the great strength of the muscles inserted in it. Although in the action of the hind-legs there cannot be the concussion to which the fore-extremities are exposed—for the weight of the body is never thrown violently upon them—yet in the powerful action of these limbs there is much strain on the joints, and in them are found, accordingly, admirable provisions against injury. The articulation of the upper part of the thigh-bone is secured not only by a powerful capsular ligament, and still more powerful muscles, but by an admirable contrivance resulting from a ligamentous rope which springs immediately from the middle of its head, and is firmly fixed within the socket of its joint. The lower end of the thigh-bone is also complicated in its form, consisting of two prominences which are received into corresponding depressions in the next bone. Over this joint several muscles of surprising strength are extended, by which it is greatly strengthened. This joint corresponds to the knee in the human subject.

The lower thigh-bone, or, more correctly, the leg-bone, reaches from this joint to the hock. It forms an angle with the upper, the reverse of that which exists between the upper bone and the pelvis. To insure speed, it must be long, for in proportion to the length of the muscle is the contraction of which it is capable; and in proportion to the contraction of the muscle is the extent of motion in the limb. Situated along the upper part of this bone is a smaller one extending a part of the way down called the *fibula*, which corresponds with the splint bones of the fore-extremities.

We now arrive at a very important joint, the *tarsus* or *hock*, which is a striking instance of the perfect mechanism displayed in the osseous structure of this animal. It is formed by an assemblage of six bones, and sometimes of seven; while in the ox, sheep, and deer, there are seldom more than five. Between these bones there is little motion, yet there is sufficient to give a spring to the parts, and to preserve the joints from the effects of shocks. The bones of the hock, like those of the knee, are united together by ligamentous fibre.

Considering the extension and action of this joint, the weight and stress laid upon it must be exceeding great, and it must be liable to much injury in rapid and powerful motion. To prevent this, the different bones are grooved into each other, and covered with elastic cartilage, by which a great deal of concussion is avoided or more readily diffused among them, being thereby so much diminished in its effects as to be rendered harmless. Each of these bones is covered not only by cartilage, but by a membrane secreting the *synovia* or oil common to all the joints of the frame, so that these bones are formed into so many distinct joints separated from each other, and thereby guarded from injury, yet united together by various ligaments possessing altogether sufficient motion, and at the same time being so strongly united as to defy dislocation.

The *hind-legs* are similar in structure and conformation to the fore-legs, which have been already described.

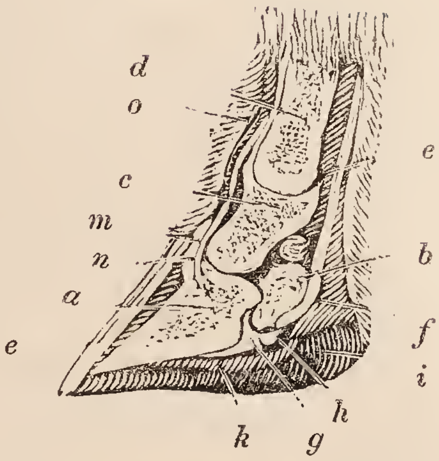
The *foot* is composed of the horny box which covers the extremities of the horse, situated within which is a series of springs with great complexity of structure, a knowledge of which is no less interesting that instructive.

The crust or outer portion of the hoof serves as a covering and protection to the more sensible and delicate parts. It is deepest in front, where it is called the toe; shallower at the sides, which are denominated the quarters; and of least extent behind, where it is termed the heel. It is placed flat on the ground, but ascends obliquely backwards, and possesses different degrees of obliquity in different feet. In a sound hoof, the proper degree of slanting is calculated at 45°. When it is more oblique the crust is said to have fallen in, which indicates undue flatness of the sole, or, if the obliquity be very much increased, pumiced or convex sole. If it be more upright than the angle mentioned, it shows a contracted foot, and a sole too concave; so that there is no necessity to take up the foot in order to ascertain either of these states of it.

The crust of the hoof is rather more than half an inch in thickness in front, and becomes gradually thinner towards the quarters and heels. It is thinner at the inner quarter than at the outer, because more weight is thrown upon it, and it is thus better able to expand as occasion requires. It is composed of numerous fibres, running at the toe in a straight direction from the coronet to the ground, but at the quarters taking an oblique direction from the heel forward. This construction is best calculated to enable the foot to expand when it comes in contact with the ground, and by that expansion to permit the gradual descent of the bones of the foot, and obviate much concussion. The crust is found to be thinner when greater expansion takes place. The fibres are held together by a glutinous substance, but in such a manner as to permit a slight degree of separation, or to bestow the power of expansion on the foot; and when recently separated from the foot it is an exceedingly elastic substance, and very tough, that it may not break and chip with the violence to which it is exposed.

The colour of the hoof is a matter of some importance. There is a common, and perhaps a well-founded prejudice against white feet. White horn is said to be weaker than that of the usual dark colour, and in white feet the sole is almost uniformly flat, and the quarters are weak.

Fig. 81.



In the annexed figure, which is a representation of a perpendicular section of the foot, *a* is the coffin-bone, situated immediately within the crust of the hoof; *b*, the navicular or nut-bone; *c*, the coronary, or little pastern bone; *d*, the large pastern bone; *e*, the back sinew, or great flexor-tendon of the foot; and *f* represents the same tendon sliding over the navicular bone; while *g* shows its termination, or connexion with the coffin-bone; *h* is the elastic matter of the sensible frog; *i*, the insensible, or horny frog; *k*, the horny sole which surrounds the sensible parts of the foot.*

The *coffin-bone* adapts itself to the form of the hoof, or rather is adapted by nature to this eligible form. Surrounding it, and lining the crust of the hoof, there are linear indentations to which a great number of semi-cartilaginous leaves are attached, and terminating in the most delicate expansion of horn, having much of the appearance of the inner surface of a mushroom.

Towards the heel this crust is parted by the horny frog. This is a triangular portion of horn, projecting from the sole, almost on a level with the crust, and covering and defending a soft and elastic substance, called the sensible frog. It is wide at the heels, and there extends above a portion of the crust, narrowing rapidly as it approaches the centre of the foot, and terminating at a point at somewhat more than half the distance from the heel to the toe.

Without the frog on each side, the fibres of the hoof are inflected, to form what are called the bars. They form an acute angle, and meet at a point at the extremity of the frog, in common with which they serve as a protection to the foot. The remaining portion of the lower part of the foot, from the bars to the outer edge of the crust, is called the sole. It is not so thick as the crust, than which it is less brittle, and more elastic. In a well-formed foot, this part is always considerably elevated to admit of due expansion on pressure being applied, without being injured by coming into contact with the ground.

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* Encyclopædia of Agriculture.

The *skin* of the horse, like that of most other animals, consists of three parts, the *cuticle* or scarf-skin, externally, the *rete mucosum*, or web-like structure underneath, and the *true skin.* The cuticle is that part which we see raised from the true skin by the action of a blister. It is produced by the true skin, and is perforated by all the pores of the latter, whether exhalant or absorbent. The rete mucosum is the substance to which the animals owe their colour, the cuticle being transparent.

The object of the skin being protection it is remarkable for its strength, and the tenacity with which it adheres to the fleshy and muscular substances underneath. Nor is it less remarkable for its elasticity, thus perfectly adapting itself to all states and conditions of the animal. This elasticity is produced by innumerable small glands, which pour out an oily fluid that softens and supples it. The flow of this fluid seems to be impeded by either want of condition or disease, and hence the unthrifty appearance an animal then assumes.

Hair is an invariable appendage to the skin in the case of the horse and many other animals. It serves to protect them from the rigours of climate, and varies in length according to the degree of heat or cold which the animal is to endure. Examined by the microscope, it is seen to be a little tube, containing a pulpy matter which runs through the whole length of it, and by which it is fed and rendered pliant. The hair is not a permanent appendage, being annually changed during the process of moulting, and during the time this process is going on, it usually affects the condition of the horse, and is attended by general lowness of spirits.

The colour of horses does not depend on their real skin, as with man, but on that of the hair, the colour of which admits of every variety. Of colour, as a criterion of excellence in horses, little can be said, as it is altogether an inferior consideration, except as a matter of taste. Good horses may, indeed, be found of every colour; and it is far more necessary to attend to the conformation and disposition of the horse than to his colour.

III.—DISEASES OF THE HORSE.

The anatomical structure and external conformation of the horse have now been briefly described. Hitherto the healthy action of the several parts has only come under observation, but the diseases incidental to him are as numerous and as important as his complicated structure, and the artificial state of his present mode of life, would lead one to expect. In his natural state, he is free from many diseases which have been brought upon him by domestication and mismanagement. Until of late, the treatment of these diseases was confined to the hands of persons possessed of a very slight knowledge of the structure of the animal, or of the functions which the several parts have to perform ; but now, that a juster knowledge of the principles of pathology is becoming more general, it may be expected that an improved system of veterinary practice will be gradually gaining ground. Practitioners of acknowledged talents are sometimes to be found, and in every case of emergency, such persons should be consulted. But as it is not always that such a one is within reach, it is necessary that the farmer, and every one interested in the management of horses, should be acquainted with the prevailing diseases, and their mode of treatment. To supply such a desideratum, therefore, a concise account of the diseases of the horse, with their appropriate remedies, will be given in this place.

In treating of the subject of diseases, the arrangement adopted in the preceding part, namely, that of dividing the carcass into head, neck, trunk, and extremities, may be conveniently pursued. But before entering on the diseases incidental to these several parts, such injuries and diseases as are not confined to any particular locality will, with propriety, come first under consideration.

Wounds. The importance and danger of wounds vary according to the nature of the parts involved. If the skin and cellular substance only be injured, the recovery is generally easy and prompt. Division of the muscular fibres, with the necessary concomitant of lesion of the smaller arteries and nervous trunks, may oppose more obstacles to the cure, but neither are these often of a serious description. But should any of the greater arterial or venous trunks be opened, any of the cavities of the body be penetrated, or the internal organs share in the injury, the wound must be considered as presenting tokens of immediate risk. One of the results of every wound, unless when it affects a part not naturally endowed with sensibility, as the horny crust of the hoof, is the sensation of pain. Farther, as all the organs admit in their texture a greater or smaller number of vessels, no wound can occur without an effusion of some part of the circulating fluid. And, lastly, the greater part of the tissues of the body being endowed with a degree of contractility, another general result of a wound is the separation of its sides, to an extent proportioned to the magnitude of the injury, and to the degree of contractile force possessed by the wounded part.

Nature establishes the cure of wounded parts in two ways. The one process is that of immediate adhesion, which is accomplished in a few days, when the wound is technically said to have healed by the *first intention.* The other is by the slower means of suppuration and granulation, through which the wound is gradually filled up, and a cicatrix ultimately formed; the process being then entitled the cure by the *second intention.*

The conditions which are favourable to the healing of a wound by the first intention are rest, approximation of the divided surfaces, cessation of hæmorrhage, and seclusion from the contact of the air. These conditions being obtained, there follows, for a few hours after the accident, a discharge from the wounded vessels of a serous or watery-looking fluid, which then changes into an effusion of what is termed coagulable lymph. This substance displays a strong tendency to organization, and, being gradually thickened by the absorption of its thinner parts, it serves as a glue to bind together the cut surfaces, which is generally accomplished at the end of two or three days, though the union be not as yet perfect. Through this lymph the blood-vessels prolong themselves, and the organization of the new matter being at length established, the cure may be said to be completed, the whole process usually occupying less than a week. The cure by the first intention is that which ought to be attempted on every occasion when there is the slightest prospect of its success, as it may be effected with greater expedition, and presents a small scar, the part remaining being clothed with original skin, a covering much better than any substitute which can be formed to supply its place.

But if it should prove impossible to attain the conditions necessary for completing the union by the first intention, the appearance of a different series of phenomena may be looked for. The pain arising from the injury continues, and increases in intensity, and towards the beginning of the second day after the accident, other symptoms of inflammation show themselves, such as the increased heat and redness, with swelling of the parts closely adjoining. The discharge is at first thin and nearly colourless, though sometimes tinged with blood, and afterwards the surface becomes covere with an effusion of lymph. About the third day there begin to display themselves a number of minute red-coloured cones, soft, and bleeding on the slightest contact, which denote the commencement of the process of organization in the effused lymph, and are known by the name of granulations. These, on being subjected to maceration, appear to be composed merely of cellular tissue, and do not present any analogy in point of structure with the particular organ from which they proceed, or of which they are henceforth destined to become a part.

In the meantime, the discharge becomes opaque, and of a yellowish-white colour, possessing the other properties of what has been termed purulent matter, and becoming thicker, more viscid, and of a purer white, as the cure advances. The process of granulation now proceeds, until the whole cavity of the wound be filled up with the newly-generated substance. A thin blue pellicle is then observed at the edge, which increases in breadth, and, proceeding from the circumference to the centre, gradually completes the covering of the wound. During this period the sensibility of the wounded part decreases, and the heat and painful distention disappear as the inflammation subsides. The newly-formed cellular tissue acquires a contractile power, by which the wound is curtailed in its dimensions, and the divided surfaces are brought close together, the bond of union finally putting on a fibrous appearance and consistency. Lastly, the newly-formed skin, from being of a blue colour, delicate in its texture, and highly vascular, becomes changed into a dense, firm, and almost insensible substance, contracting, at the same time, its dimensions still farther. With this concludes the healthy and natural process of cure by the second intention, which, it may be observed, admits of division into three stages; namely, those of inflammation, usually, in large wounds, accompanied by general sympathetic fever, and lasting from three to six days; of suppuration, the duration of which is irregular; and of cicatrization, by which the healing of the wound is at length fully accomplished. Such are the series of phenomena presented during the different stages from the period of the infliction of the wound, until the cure is finally accomplished.

The treatment of wounds is somewhat different according to the different circumstances under which they occurred, as these determine, in a great measure, the amount of injury inflicted. The main object in the greater number of cases of incised wounds ought to be to obtain an union by adhesion. Wounds cannot be said to be capable of union by adhesion, unless they are recent, and their margins can be brought into close approximation. The first care in dressing a wound of this description ought to be directed towards ascertaining its extent and depth, and the precise nature of the parts involved, by gently separating its sides, washing away the blood by which it is covered, and removing all foreign substances, such as sand or other matters, should any be present. The two sides of the division must then be brought into contact, and so carefully retained. For this purpose, in very slight cases, when the injury extends only to the skin, or the tissues immediately subjacent, the use of adhesive plasters, either alone or aided by a uniting bandage, may be sufficient, and, in such cases, they ought to be preferred ; but it will be generally requisite, in considerable wounds, that one or more sutures, or stitches, should be employed.

The precise method to be employed in dressing a wound made by incision must be adapted to the particular nature and situation of the injury. If a bandage can be applied so as to keep the edges of the wound in contact, it ought to be preferred as the least irritating dressing. When its use is not likely to be attended with advantage, strips of adhesive plaster come next in order as fitted to promote the sanative union ; but it is only in slight cases that their unassisted use is likely to prove efficient. The suture must be had recourse to only when the other methods are insufficient or impracticable ; but the stitches, in large wounds, should be always assisted by the use of plasters. It is scarcely necessary to add, that wherever one kind of dressing can be made to assist another, they ought to be combined as circumstances may admit or require.

It will seldom be necessary to attempt the removal of the dressings before the second, or more frequently the third day after they have been applied. Care must now be taken not to expose the animal to unnecessary torment, or the still imperfect cicatrization to risk of damage, by hasty or violent handling. The dressings should be softened by tepid water when they adhere through the hardening of effused blood or other matter; and when plasters have been applied, they should be removed by raising their extremities, and pulling them from each side to the line of the wound, so as to avoid all danger of reopening it. Long exposure and much handling of the wound should be avoided. The injured parts should be lightly washed before the application of fresh dressings, as want of cleanliness will often prove a serious obstacle to the cure. The mode of treatment which has been described will, in most cases, prove successful; but if, after exposing it to a fair trial, it be found that the wound shows no tendency to unite, another mode of treatment may be requisite. The injury is, in this case, healed by the slower process of suppuration and granulation.

Whenever the margins of an incised wound cannot be brought into close contact, and its surface covered by sound integuments, there can be no hope of a cure, excepting through the medium of the suppurative process. A wound may be in this condition, either through a loss of substance which may characterize the injury, through neglect in the first treatment, or through such conditions of the general system or of the parts injured, as are known to be unfavourable to the adhesive union.

In the case of the adhesive union being impeded by an excess of what may be termed simple healthy inflammatory action, evinced by considerable swelling in the parts adjoining the wound, and by the prominent, firm, and vividly red appearance of the granulations on its surface, this will ordinarily be best allayed by the use of warm fomentations or poultices. But, in some cases, it may be necessary to have recourse to general or local blood-letting, and a restricted diet; and, on the action being subdued to its proper pitch, dressings with simple ointment, repeated daily, will serve to complete the cure. The use of caustic and irritating applications to wounds in this state, and indeed to wounds generally, does not in any degree contribute to the healing of the part; and they inflict much unnecessary torture on the animals to which they are applied.

Should the inflammatory action still be in active progress, the object must be to reduce the morbid state of excitement to the just standard. For this purpose fomentations and emollient poultices will be necessary, and the fomentations should be repeated at least twice daily, morning and evening, for half an hour at a time, and the sore should be covered during the intervals with warm poultices frequently repeated. When the irritability lessens, and the sore assumes a healthy appearance, a piece of soft dry lint may be placed between it and the poultices, which may soon be altogether discontinued.

But should the action, on the other hand, be deficient, recourse must be had to stimulating applications, such as the common resinous ointment, or lotions composed of camphorated spirits, or of some of the warm tinctures. The repeated moderate application of lunar caustic will often be highly useful in this kind of sore, and washes composed of white or blue vitriol in solution may sometimes advantageously supply the place of spirituous lotions. But never, even in this condition of a wounded part, should the sore be crammed with powdered blue vitriol, or similar substances, as is sometimes recommended. The indolent condition of wounds being one which is usually brought on by some morbid state of the system, regard must be had to the general health of the animal under treatment. As in the former case, bandages will now be necessary; but in suppurating wounds with an excess of action, they should be applied loosely, as the parts would suffer by constriction. In such as show deficient action a moderate degree of tightness is advisable, and often of great service. In the healthy suppurating wound, bandages should not exercise a greater pressure than is sufficient to keep them in their place.*

Strains. When any particular part has undergone excessive extension, it is denominated a strain; and those parts which are liable to such accidents are the muscles, ligaments, and tendons, with their appendages. Such over-distention may proceed from slips, blows, or from hard or violent exercise, by which the muscular or tendinous fibres are overstretched, and sometimes ruptured or broken. In order to form a just idea of the nature of this affection, we have only to consider that the parts affected are composed of an assemblage of elastic fibres, having a certain power of their own to contract and extend themselves; and that this function has been forcibly impaired by an increased degree of distention to which the elastic power was unable to extend. Strains are, however, generally of a more serious nature than those injuries arising merely from excessive extension, and often depend on a rupture of the parts affected as well as their over-distention.

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* For further information on the nature and treatment of wounds, see an admirable article in the Quarterly Journal of Agriculture, vol. iv. from which the preceding remarks have been for the most part abridged.

The treatment of this class of injuries must depend, in a great degree, on the situation of the parts affected. Bleeding and rest are usually the effective remedies, and, if resorted to at an early stage, will seldom be unsuccessful. It must be evident, however, that in all violent strains of either tendons or muscles, whatever opinion may have been entertained of bathing and anointing with favourite remedies, which often succeed in slight cases in which bandaging alone would have answered; it is the latter, with proper resting of the relaxed fibres until they have thoroughly recovered their tone, that is chiefly to be depended on. From the nature of the injury, rest would appear to be indispensably necessary towards effecting a cure, and in practice this is found to be the case. Emollient poultices are sometimes applied with advantage in the case of strains of a serious nature. Attention must also be paid to the general health of the horse at the period; he is to be kept on low diet, and his bowels are to be kept in a proper state, by medicine if necessary, as being essential to healthy action of any description. If, from the situation of the parts affected, the animal is able to move about, he may with propriety be turned out to a convenient grass paddock; but care must be taken that he is secured from annoyance and excitement, as an instance of over-exertion during the period of convalescence may retard the recovery of the animal.

Inflammation. This is a disease or affection consisting in an increased circulation of the blood, arising from irritation, external or internal, local or general. It seems to arise from an affection of the blood-vessels, and perhaps from a peculiar state of the blood itself. Various circumstances may be regarded as conducive to inflammation; but, whether general or local, it is usually brought on by inordinate excitement, such as over-feeding, excessive heat, the reaction produced after cold, and the reaction produced after inordinate exertion.

General or diffused inflammation is attended by an increased action of the heart and arteries, accompanied with an increase of heat. In some instances when the fever is purely symptomatic, and dependent on the inflammation of some important organ, as of the lungs or intestines, the circulation appears retarded rather than increased, from interruption arising to its passage through the heart.

Local or confined inflammation is also dependent on an affection of the blood-vessels, but confined chiefly to those of the part affected. The principal symptoms are, heat in the part, or over the whole system, pain, swelling, redness, an accelerated pulse, and a dryness of the skin. The first is caused by the reciprocal action and reaction of the solids and fluids. The irritation on the fibres increases the action of the vessels, the velocity of the fluids is thereby quickened through them, and thus heat is produced. The pain is a consequence of the great distention of the vessels in a part already become preternaturally sensible. The swelling is not caused by obstructed blood, as is often supposed, but by the excess of heat distending the cellular membrane; though swelling is not essential to inflammation. The redness proceeds from the quantity of blood brought to the part; but this symptom is not always to be distinguished in the lower animals. The quickened pulse proceeds from that law in nature by which the heart always increases its efforts to free its subservient vessels from any injury they sustain from accidental or unnatural irritation. The dryness of skin arises from the stricture of the capillary vessels, whose use is nearly abolished by the irritation under which they are labouring.

Inflammation sometimes soon goes off, at others it is removed with difficulty, and it frequently terminates in other diseases. In the horse its progress is exceedingly rapid, for which reason the most decisive and speedy remedies are called for, especially in all cases of internal inflammation. With respect to its removal there is only one general method, which is, that of lessening or removing the irritation, and diminishing the increased afflux of the humours. But, at the same time, regard should be had to the structure, situation, and connexion of the parts, the antecedent causes of the disease, and the state of the animal.

From the nature and causes of inflammation, the remedy would appear to consist in the use of bleeding and purgatives. All other remedies are unimportant compared with bleeding; and in local inflammation, local bleeding will be resorted to. This will at once check the rapidity of the disease, and may altogether in many cases subdue it; at all events, it will rarely return with the same degree of intensity; but it is to be observed, that it should take place at an early stage of the disease, and the practitioner need not hesitate to bleed largely. The circulation being lessened by these means, an effort is to be made to remove something from the bowels, the retention of which would increase the general irritation and fever. In certain cases, however, much judgment is necessary in determining whether a purgative may be beneficial or injurious. In inflammation of the lungs or bowels, it should never be given, as a sufficient degree of irritation is already in operation, and by increasing it by means of a purgative, such a degree of inflammation might be produced as would speedily have a fatal termination.

In cases of external inflammation, it is often difficult to decide whether a cold or hot application should take place to the part. The former is intended to diminish the irritation of the part by a reduction of temperature, and is to be preferred in the early stage of the disease, especially when it is not deeply seated; but in more formidable cases, the latter will be properly resorted to with a view of promoting perspiration, and thus lessening the tension and swelling of the part and abating the disease.

Fever. Fever is a consequence of increased arterial action, either without any local affection, or in consequence of the sympathy of the system with inflammation in some particular part. The first is pure fever, and is of rare occurrence; the latter is called symptomatic fever, and it is generally present in every case of high inflammatory action.

The treatment to be adopted in this case, is similar to that in inflammation. Blood is to be taken from the animal until the system is affected, after which, a mild purgative may be administered, morning and night, until the bowels are slightly relaxed. Digitalis, emetic tartar, and nitre are to be given as accompaniments, and these may give way to white hellebore, in doses of half a drachm twice in the day. In the event of any tendency to inflammation of the lungs, warm clothing will be essential, but perfect ventilation must be secured.

1. *Diseases of the Head.*

The diseases of the head are numerous, and often of such a nature as to baffle the most skilful exertions towards a cure. The parts liable to be affected are the brain, the eyes, and sometimes the mouth. The bones forming the cavity have also, in peculiar cases, been fractured, but this is of rare occurrence; and it is fortunate that it is so, for it is invariably fatal.

Meagrims. This disease is the consequence of a too full habit, and an obstruction of the blood-vessels of the brain. The arteries pursue their course to this organ in a strangely winding and circuitous manner, and in certain parts of their course they do not admit of enlargement to any considerable extent; yet, from various causes, more than the requisite portion is occasionally sent to the head, and thus the larger vessels of the brain will be too long and injuriously distended, and, what is of more consequence, the small vessels which run through the substance of the brain will be enlarged, and the bulk of the brain itself will be increased. This will materially interfere with the healthy action of the nervous system, and produce, almost without warning, loss of power and consciousness. The disease may be produced from over-exertion on a journey during hot weather, or from some negligence in the mode of adjusting the harness about the head and neck, by which the circulation is impeded. But this will only occur with horses naturally predisposed to the disease.

Meagrims being the result of a too full habit of body, bleeding is the most efficacious, and almost the only remedy which can be employed. At the moment of attack, three or four quarts of blood should be taken from the neck vein, and this will, in general, procure relief. The bowels should afterwards be kept open, and it will be of service to allow the horse a run at grass.

Inflammation of the Brain, or Brain Fever, is a very formidable disease. It shows itself, in general, by disinclination to food and motion, drowsiness, accompanied by heaviness and closing of the eyelids, with moisture and redness of them, and also of the linings of the mouth and nose. Sometimes these symptoms increase, until the horse becomes comatose, and, after a few frightful struggles, he sinks to rise no more. In these cases, the pulse is liable to be oppressed instead of increased, as is usual in inflammation; but, most frequently, after the first stages, he becomes furious, plunges about, and is vicious to himself and others, approaching to a state of madness, in which state he continues till he sinks from his own exertions, when he rises again to renew his violence. Hence the term *mad-staggers* is frequently applied to the disease.

The causes of staggers may be various. The immediate cause is either an original accumulation of blood within the brain, or the removal of the inflammation of some organ to the brain. As a remote cause, it is often brought on by too full feeding without sufficient exercise, particularly in horses at one time working very hard, and at another suffered to remain inactive, and being in both cases equally fed.

The treatment adopted by the best practitioners is too often unsuccessful. The animal should be bled until he faints or drops; or if he be down, until he is evidently faint and weak. Both the neck veins should be opened at once, and the fulness of the stream, or the quickness with which it is taken, is almost as important as the quantity. Aperient medicine should then be given, and that whose action is quickest should be preferred. This will be the croton nut, powdered at the time, and given in a drink, in a dose of half a drachm, and followed by smaller doses of ten grains each, every six hours, with plenty of injections of warm soap and water, until the bowels are opened. Such medicines should afterwards be given as have a tendency to lessen the circulation, and, consequently, the determination of blood to the head.

Tetanus. Another disease having its origin in the brain is tetanus, or locked-jaw. This is one of the most dreadful and fatal diseases to which the horse is subject. It is called locked-jaw, because the muscles of the jaw are earliest and most powerfully affected. It is a constant spasm of all the voluntary muscles, and particularly of the neck, the spine, and the head. It is evidently an affection of the nerves, and generally arises from a wound, and oftenest from a wound of a tendinous or ligamentous part. The time of attack is uncertain, and may be postponed until the wound is nearly, or quite whole.

Tetanus being the result of a wound, the first step towards a cure should be to increase the irritation of the wounded part, by the application of caustic, or by making a deeper incision, observing to keep the wound open by a little digestive ointment. The new irritation thus produced may lessen or remove the old one. In treating the constitutional disease, efforts must be made to tranquillize the system, and the most powerful agent is bleeding, which will serve to allay the irritation. Temporary relaxation of the spasm will at least follow; and this will give an opportunity of allaying it still further by physic. Croton, as being the most active purgative, should then be administered in a dose of half a drachm, and repeated in doses of ten grains, at intervals until it operates. The operation of the physic may be assisted by injections of aloes dissolved in warm water. The whole of the spine should be blistered, three or four inches wide. The horse being placed in a warm stable, and well clothed. Opium may afterwards be administered with a view of still further allaying the irritation, in a dose of a quarter of an ounce, reduced to powder, and made into a drink with gruel; and an additional drachm may be given every six hours after.

The Diseases of the Eyes are not numerous, but they are destructive, being frequent in their appearance, sadly obstinate, and often baffling all skill towards effecting a cure. The eye of the horse, indeed, appears to be more naturally disposed to disease than that of any other of the domestic animals.

The eye is occasionally wounded through the inadvertence or carelessness of the attendant; but the injury more usually extends to the parts surrounding the eye than to the eye itself. It is placed on a mass of fat, in which it turns readily, and thus escapes injuries which would otherwise take place; but the substance around the eye may be deeply wounded, and very considerable degree of inflammation ensue, which is to be abated by poultices, bleeding, and physic. Warts are also sometimes attached to the edges of the eyelids. They may be taken off with a scissors, or a knife, and their roots touched with the lunar caustic. Should an artery be cut through in removing these excrescences, the bleeding may be stopped by securing the ends with forceps.

The eye of the horse is also subject to inflammation. This disease sometimes occurs under a mild form, being of short duration, and presenting little difficulty in the management. Occasionally, however, it presents a more serious aspect, and is often fatal to the eye. The latter species of inflammation is the *ophthalmia*, or *moon-blindness*, so much dreaded by horsemen.

The common inflammation is generally sudden, and often strangely whimsical in its attacks. A horse may be as well as usual in the evening, and next morning the eyelids will be found swelled, and exceedingly hot and tender, the eyes partially closed up and cloudy, a considerable flow of tears accompanied by languor and pain. This frequently arises from some injury inflicted on the part, or from the presence of some foreign body, such as the seed of the hay, or similar matters, and, therefore, it will be well to examine the eye with a view of ascertaining the cause of injury. It is also frequently connected with catarrh, and discharge from the nose; but at other times the eye alone will be the part affected, and that without any appreciable cause.

This disease is usually easily got rid of by darkening the stable, and applying a simple wash to the eye, and often indeed without any medical treatment whatever. But should any considerable time elapse, and the inflammation still continue, the presence of the true ophthalmia may be calculated on with certainty. This disease will be found more obstinate, and strangely whimsical in its symptoms, sometimes appearing very ill, and all at once without effort, assuming a more favourable aspect. It is frequently termed moon-blindness, it being vulgarly supposed to be influenced by that luminary.

As this is a constitutional disease, brought on by artificial habits, as over-exertion, close and unhealthy confinement, and heating food, so, it must be evident, the abstraction of all these is necessary to remove the complaint, and to prevent a recurrence; but especially the dark, close, and unventilated state of the stable should be attended to, as well as the removal of the litter, which retains the volatile alkali of the urine, and irritates the eyes considerably. The food should be mild and cooling, and the exercise moderate, but long-continued. Under the height of the attack, however, rest is advisable, with moderate light, which may be still further moderated by keeping over the eye or eyes a thick cloth wet with goulard water. Sometimes a solution of vinegar in water has been found a useful application; and whichever is used, the eyebrows should be kept continually wet with it, which, by exciting evaporation, will keep the part cool. A seton may be introduced under the eye or jaw. In some cases, blistering the forehead or cheek is found useful; and in every instance bleeding is proper, which should be repeated until the disease lessens; and local bleeding will be found most efficacious. When the horse is very full and gross, physic and alteratives assist the cure. When blistering is used in any part near the eye, care must be taken that the blistering matter is not rubbed into it.

The most frequent consequences of this disease are cloudiness of the eye and cataract. The cloudiness is singular in its nature. It will change in a comparatively short space of time from the thinnest film to the thickest opacity; and, as suddenly, the eye will regain its perfect transparency, but only to lose it, and as rapidly, a second time. This being the effect of inflammation in the eye, it is needless to attempt its removal by the application of substances calculated rather to increase that inflammation than to allay it. When the cloudiness can be removed, it will be best effected by first abating inflammation, and then exciting the absorbents to take up the grey deposit, by washing the eye with a very weak solution of corrosive sublimate.

Another species of blindness is the *Gutta serena*, or glass-eye, so called from the peculiar glassy appearance of the eye, arising from a paralysis of the optic nerve. As the eye is not materially altered in appearance, a horse often becomes blind without its being noticed, until his cautious stepping, quick motion of the ears, and other indications of defective vision, give notice of the case. On examination, it will be found that the pupil remains dilated, however great the light, and the eye is irrecoverably lost. In the early stages, blisters to the forehead, and stimulants to the eyes, may be tried, but there are very faint hopes of success.

Catarrh or common Cold. Although a disease not confined to the head, yet, from the symptoms generally becoming first apparent there, catarrh may, with propriety, be treated of in this place. It is a complaint of very frequent occurrence, and generally subdued without much difficulty, but often becoming of serious consequence if neglected. It is accompanied by a little increase of pulse; a slight discharge from the nose and eyes; a diminution of appetite, and cough, sometimes painful and frequent. A little warmth and a few mashes will generally effect a cure, without the aid of medicine.

Catarrhal Fever. This disease, though at all times distinguished by some common and characteristic symptoms, is strangely different in different years, and in particular seasons of the same year. It is usually sudden in its attack, and appears at first like violent catarrh, commencing with a shivering fit, accompanied by some degree of fever, greater heat of the skin than is natural, heaving of the flanks, and cough. The animal will also suffer from extreme weakness, and will frequently stagger and keep on his feet with difficulty. Swellings also sometimes appear in different parts, under the brisket, or round the fetlock, or following the whole course of the flexor tendons. These are not unfavourable if they are not of too great an extent, and if the breath is not very fetid; but if after some time the membrane of the nose becomes of a livid or purple hue; or the extremities, which had been variable in temperature, become cold, or the flanks begin to heave laboriously, there is every probability of the disease rapidly running to a fatal termination.

In the treatment of catarrhal fever, promptitude and decision are requisite, though much caution is also necessary. Being febrile in its commencement, blood must be withdrawn, and that freely; but not until weakness is produced, for although the inflammation must be subdued, the characteristic debility attendant on the disease must not be increased. The bowels are next to be gently opened, if they are not already somewhat loose, and this will be best effected by administering two drachms of Barbadoes aloes, succeeded by doses of an ounce at intervals, until the desired effect is produced. Should the fever not be abated, the usual sedative medicines are to be employed, with perhaps two drachms of nitrous ether when the fever is somewhat subdued.

Glanders. This is the most formidable disease to which the horse is subject, and one which has hitherto baffled the united exertions of the most experienced veterinary practitioners. Instances, indeed, are recorded of cures being effected; but the remedies adopted in these cases have signally failed in others, so that the proper treatment of the disease, to effect a cure, may be regarded as involved in the greatest obscurity.

Glanders is an affection of the membrane of the nose, consisting of the secretion and discharge of a poisonous matter, which at length vitiates the constitution of the animal. Before the termination of the disease, it becomes connected with farcy. Few horses die of glanders without exhibiting some appearance of farcy; and farcy, in its later stages, is almost invariably connected with glanders;—they are, in fact, different forms or stages of the same disease.

In the first stages of the disease, the discharge from the nose will not differ from that in a common cold, but by degrees it becomes more purulent, proceeding from the excessive ulceration of the nostrils. As the disease proceeds in its course, the ulcers extend so as to impede the passage of the air in breathing, and threaten suffocation. The ulcers finally extend to other parts of the body—symptoms denoting approaching dissolution. Thus it appears that the membrane of the nose is the original seat of glanders; that the disease is, for a time, purely local; that the inflammation of the tubercles must proceed to suppuration before that matter is formed on which the poisoning of the constitution depends; that the whole circulation at length becomes vitiated; and that the horse is destroyed by the general irritation produced.

Glanders may be produced by anything that injures, or for a length of time acts upon and weakens, the vital energy of the membrane. It has been known to follow a fracture of the bones of the nose. It has been the consequence of violent catarrh, and particularly the long-continued discharge from the nostrils, of which we have already spoken. It has been produced by the injection of stimulating and acrid substances up the nostril; and every thing that weakens the constitution generally will lead to glanders. Defective stable management, and improper and undue exertion compared with the manner in which the animal is fed, may be very generally believed to be the origin of the disease.

Glanders, however, is highly contagious. This must never be lost sight of by the farmer, and the moment he suspects that one of his horses is glandered he should be separated from the others. A sound horse cannot with safety be put into a stable in which a glandered horse has been until after it be thoroughly fumigated, the walls whitewashed, and the rack and manger well brushed with soap and water. The slightest contact with the matter of a glandered horse is, indeed, capable of producing the disease.

With respect to the treatment of this hitherto formidable disease, a few words will suffice. Nothing certain can be advanced either in the way of prevention or cure. Improper treatment has been seen to be a cause of the disease, and a preventative would therefore appear to consist in better management. When the disease has made its appearance, all attempts towards effecting a cure will be, in general, fruitless. One thing, however, is certain, that it is contagious, and the contact with a diseased animal should, therefore, be carefully avoided.

In administering medicine to a glandered horse, the practitioner must take care that his hand be free from any kind of injury, as the human being is as liable to be infected as the horse by the slightest portion of the glandered matter coming in contact with a sore; and there are cases recorded of lives being lost by infection caught from horses suffering under this formidable disease.

Farcy. This disease cannot be regarded as a local one, as it extends over the whole animal; but it naturally comes in here as being intimately connected with glanders; they will run into each other, or their symptoms will mingle together, and before either arrives at its fatal termination, its associate will almost invariably appear. An animal inoculated with the matter of farcy will often be afflicted with glanders, while the matter of glanders will frequently produce farcy. They are different types or stages of the same disease. There is, however, a very material difference in their symptoms and progress, and this most important of all, that while glanders are generally incurable, farcy, in its early stage and mild form, may be successfully treated.

Farcy is to be regarded as a disease of the absorbents of the skin. Like glanders, it is supposed to spring from infection or bad stable management; and is produced by all the causes which give rise to that disease, but with this difference, that it is more frequently generated, and is sometimes strangely prevalent in particular districts. Before the matter of farcy can become contagious, it must come in contact with a wound or sore.

The first indication of farcy is often denoted by the appearance of little tumours, termed *farcy-buds.* These generally appear before the disease is otherwise indicated by loss of condition or appetite, and when they are small, and not numerous, they may exist for some time without being discovered; but at length they increase in number and size, and become painful and hot, and some of them begin to ulcerate. They appear usually about the face or neck, or the inside of the thigh, and in the latter case there is some general enlargement of the limb, and lameness.

In some cases, however, the presence of the disease will be indicated by the general appearance of the animal, and his falling off in condition, before the appearance of these tumours; and in certain cases, even after making their appearance, they do not ulcerate, but become hard and difficult to disperse. The progress of the disease is then suspended, and possibly for many months the horse will appear to be restored to health; but he bears the seeds of the malady about him, and, all at once, the farcy assumes a virulent form and hurries him off. Larger tumours then appear, which ulcerate and spread, after which glanders speedily appears, and death ensues.

Although farcy is thus identified with glanders, it is somewhat more manageable than that complaint. There are very many cases of the apparent recovery of the farcied horse, and not a few in which the disease has been permanently eradicated; but it is only when confined to the corded absorbents or superficial ulcer or swelled limb that it admits of cure; when the deep corroding ulcer appears, or the swelled head, and the fetid discharge, the case is as hopeless as that of confirmed glanders.

The treatment of farcy varies with the form it assumes. In the bud or button farcy, a mild dose of physic should first be administered. The buds should then be carefully examined, and if any of them have broken they are to be touched with the cautery, and afterwards washed with a lotion composed of corrosive sublimate dissolved in rectified spirit, and when they begin to heal, a dressing of Friar's balsam will hasten the process. As soon as the physic has ceased to operate, the corrosive sublimate may be given as an alterative in doses of ten grains, gradually increased to a scruple, with two drachms of gentian and one of ginger, repeated morning and night until the ulcers disappear. In the treatment of the farcied horse the same precaution is to be observed as in the case of glanders, to guard against any of the matter from the infected animal coming in contact with a wound or sore on the hands of the practitioner, there being cases authenticated of the disease being thus communicated, and human lives being sacrificed attending animals infected with this formidable disease.

But farcy is sometimes attended by immoderate swelling of the legs and several other parts, and in this case it will be prudent to bleed moderately as well as to physic. The same alterative medicine will be useful, and the swelled part should be frequently fomented with warm water. In both cases, although the air should be fresh and cool, the horse should be warmly clothed.

Strangles. This is a disease peculiarly incident to young horses, and one from which few, if any, escape. It usually appears between the third and fourth year, and oftener in the spring than in any other part of the season. When it occurs in the case of the young colt at grass, it goes through its course easily, and without pain or inconvenience to the animal, if it is not interfered with; so little, indeed, is the inconvenience it occasions in this case, that it often escapes notice. Those colts which escape the strangles at grass are liable to be seized when they are first taken up and put to work.

The disease is at first preceded by a cough, from which, in its early stage, it can scarcely be distinguished, except that there is more discharge from the nostril, of a yellowish colour, mixed with matter, but generally without smell. A swelling soon appears under the throat, which increases with uncertain rapidity, accompanied, in general, by some fever and disinclination to eat. The swelling increases until it comes to suppuration, when the tumour bursts, and a great quantity of matter is discharged, after which the animal speedily recovers.

The treatment of strangles is simple, and consists in bringing the swelling to suppuration as soon as possible, which will be best accomplished by the application of an active blister. As soon as this takes place, the swelling is to be freely and deeply lanced. If the incision be deep and large enough, no second collectionof matter will be formed; and that which is already formed may be suffered to run out slowly, all pressure with the fingers being avoided. If there be the appearance of much fever, it will be proper to bleed; however, in other cases, this will be rather injurious than useful. A few cooling medicines may be given as the case requires, such as nitre, emetic tartar, and perhaps digitalis. Bran mashes and green food are to be given as the animal becomes able to eat; and in cases of great debility, a small quantity of tonic medicine, as camomile and gentian, with ginger, in doses of a couple of drachms, may be administered, with good effect.

Lampas. This disease consists in a swelling of the rugose folds of the roof of the mouth, near the front teeth, which rise sometimes higher than the teeth. It may arise from inflammation of the gums, extended to the bars when the horse is shedding his teeth, or from some febrile tendency in the animal. It will generally subside of itself; but a few slight cuts across the bars with a lancet, or penknife, will relieve the inflammation, and cause the swelling to subside.

In breaking-in young horses, the mouth is frequently injured by the bit, the bars become greatly inflamed, and are liable to become carious. All foreign matters adhering to the part should be removed, and the sore dressed with a solution of alum or of tincture of myrrh, after which the horse should be kept on soft food until the part becomes healed.

The mouth is also sometimes injured from the irregular wear of the grinders, and consequent sharp corners which are formed on them, which inflict severe wounds. Such parts are to be removed by the file or saw, and the teeth thus operated upon should be repeatedly examined, as similar projections are again likely to be produced.

2. *Diseases of the Neck.*

Poll-evil. This disease is produced by the horse rubbing, and sometimes striking the upper part of the head against the manger, or hanging back in the stall, and bruising the part with the halter. Repeated injuries of this kind produce, at length, inflammation of the first vertebra of the neck, and the matter that forms in consequence, being so completely confined, spreads and renders carious the under surface of the ligament of the neck, as well as the posterior part of the occipital-bone, and sometimes of the atlas, or first bone of the neck. Matter formed in this situation is not easily removed, which renders the treatment of the disease extremely difficult.

The inflammation will, in the early stage, generally be abated by bleeding, physic, and the application of cold lotions to the part; but should the swelling increase, matter will be formed in the tumour, and then the object should be to hasten the formation of it by warm fomentations and poultices. An opening must then be made in a lateral position, so as to carry off the matter, which is to be kept open by the insertion of a seton. This part of the treatment will demand the utmost skill of the most experienced practitioner.

Sore throat is common to horses in colds and strangles. It is first discovered by the horse chewing his hay; but, instead of swallowing, he drops it from his mouth. He likewise shows a disinclination to drink. In every case, the animal feels great difficulty in reaching to anything that stretches his neck downwards or upwards. His food and drink should, therefore, be placed in such a situation that he will experience no difficulty in reaching to them; and the former should be of such a description as to be easily swallowed, and not calculated to increase the irritation.

3. *Diseases of the Trunk or Body.*

Fistulous Withers. This is inflammation of the dorsal vertebræ, produced by pressure on the part. A deep-seated abscess is the consequence; and the matter penetrates in different directions before it arrives at the surface, where, at length, it causes a tumour difficult to heal. It may sometimes be abated by cooling embrocations; or, if these fail, by the application of poultices and warm fomentations, the matter being drawn off by a seton, as in the case of poll-evil. These diseases are, indeed, closely allied in their nature, and require similar treatment to effect a cure.

Inflammation of the Lungs. In treating of general inflammation, it has been seen that the disease has its origin in an affection of the blood-vessels, arising either from some internal or external exciting or irritating cause; and when the effects of this irritation are confined to any particular part of the system, it constitutes local inflammation. Such are inflammation of the brain already treated of, inflammation of the lungs now coming under notice, and that of other parts yet to be explained.

From the intimate connexion existing between the circulating system and the skin, and the important functions discharged by the lungs in the animal economy, it will be easily perceived that they must be peculiarly subject to inflammation. The exciting causes are sudden changes from heat to cold, undue exposure to cold while the animal is hot, and, erhaps, the transference of general fever to the lungs, previously disposed to inflammation from defective stable management. Neglected catarrh, or catarrh treated with stimulants, instead of cooling medicines, may also bring on the disease. Hard riding is a very common cause, and high feeding also.

Inflammation of the lungs sometimes commences slowly, the first symptom being a hard, dry cough, which seldom excites much alarm; gradually, however, the cough appears to give the horse pain, and it is accompanied by shivering, and unusual cold in the extremities, a violently-increased circulation of the blood, heaving at the flanks, and expanded nostrils. The membrane of the nose is of an intensely-florid red, and the countenance appears singularly anxious, and indicative of suffering, the animal often looking round to his agitated flanks. These symptoms continue to increase in intensity, until the vital powers become completely exhausted, which sooner or later occurs, according to the intensity of the disease. It occasionally destroys the animal in less than twenty-four hours, and then the lungs present one confused and disorganized mass of black matter. But more frequently the disease is of longer standing, especially when the lungs still continue sufficiently pervious to admit some blood.

The treatment of a disease so rapid in its progress, must evidently be of the most decisive kind. The first thing, first in order and effect, is to bleed, and that most copiously. A broad shouldered fleam or lancet should be used, and the blood drawn in the fullest stream that can be procured, until the pulse first rises, then falters, and the animal shows symptoms of faintness. Should the symptoms appear again, a second bleeding may take place six hours afterwards, and in certain cases a third, regulating the quantity of blood by the state of the patient.

It being a universal law in the animal economy that two exciting causes cannot be kept up in the same place at the same time without affecting each other, advantage must be taken of this, and external inflammation of the most active kind produced around the region of the lungs, with a view of lessening that internal inflammation which there is so much reason to dread. Blisters are therefore to be applied, and to secure their full operation the hair should be closely shaved off the part. When the internal inflammation is at its greatest intensity the blisters will probably not act, as the external parts in the neighbourhood are incapable of excitement. The proper time of applying the blisters is immediately after bleeding, when the violent action has been somewhat subdued.

An endeavour must now be made to open the bowels, and this is to be done with extreme caution, as, from the great sympathy existing between the lungs and the bowels in the horse, an active purgative would instantly prove fatal. The better plan is to back-rake and administer clysters, or perhaps half a pound of Epsom salts dissolved in warm gruel may be given. Having produced a little relaxation of the bowels, cooling and sedative medicines, such as nitre, digitalis, and emetic tartar, in the doses already recommended, may be administered.

An endeavour should also be made to facilitate the circulation of the blood throug the different parts of the system, in order that it may be withdrawn as much as possible from the lungs. Long-continued friction of the extremities will therefore be useful, by producing heat, and they should then be covered with thick flannel bandages to retain it. Efforts must, indeed, be made to restore the natural heat to the different parts of the body by warm clothing; but the horse must not, by any means, be kept in a heated atmosphere, for the inhalation of heated air into the cells of the lungs would increase the excitement, already too great. The food during this time must be of the least exciting kind. In forty-eight hours the fate of the animal will generally be decided. If there be no remission of symptoms, the inflammation will run on to congestion of the lungs, and consequent suffocation or gangrene. Should the symptoms gradually subside, the animal must still be kept on low diet, as the least exciting substance would renew the disease.

Pleurisy. Closely connected with inflammation of the lungs is pleurisy. This is inflammation of the pleura, or membrane covering the lungs, and lining the chest. The causes are the same as those producing inflammation of the lungs, and the disease is also characterized by similar symptoms. It is not, however, so intense in its action, the blood still flowing with facility through the substance of the lungs, and may be distinguished from the former by the different state of the circulating fluid, there not being the oppressed pulse of inflammation of the lungs. The treatment here is similar to that recommended in the former case, the only important difference being, that aperients may be administered with a greater degree of safety.

Thick Wind. This is generally a consequence of previous inflammation, but sometimes it is produced by a peculiar conformation of the chest, or from the previous habits of the animal. It consists in short, frequent, and laborious breathings, especially when the animal is performing any exercise. A horse unused to exercise will also be thick-winded, because the lungs will not soon accommodate themselves to the increased function which they have to perform. Of the treatment little can be said. Attention to diet, preventing the horse from overloading his stomach, and avoiding exercise soon after meals, may in some degree palliate the disease, and render the animal better fitted for the labours required of him.

Broken Wind. This disease is sometimes a consequence of inflammation in the lungs, but is often produced by other causes. It consists in the rupture or running together of some of the air cells of the lungs, by which respiration is impeded. In this disease the inspirations are performed in the usual manner, but for each inspiration two expirations are required, which may be ascertained by observing the laboured efforts of the horse's flanks in breathing. This sufficiently distinguishes it from thick wind.

Broken wind is generally the result of improper management. A horse performing severe labour, and supported on coarse and innutritious food, requires to overload his stomach to procure a sufficient supply to enable him to perform his work. But this undue extension of the stomach necessarily presses upon the lungs, and thus impedes healthy respiration. The evil effects of a distended stomach are still further increased by active exercise immediately after eating, hence a common cause of broken wind. From this the necessity of proportioning the quality of the food to the work to be performed is apparent.

When this disease has made its appearance it is needless to attempt a cure, as this has never been accomplished; but much may be done in the way of palliation. The chief remedy consists in supplying the animal with food of a more nutritive description, a smaller quantity of which will suffice, and the lungs will be less oppressed in their action. The horse should not be put to work requiring sudden exertion, as this would increase the malady. Under this treatment he may considerably improve, and be able to perform ordinary labour; but a radical cure is not to be expected.

Stomach-staggers. This disease is closely allied in some of its symptoms to mad-staggers, or inflammation of the brain, already treated of. In every case of stomach-staggers, the stomach has been found distended with food as soon as the least symptoms of the disease have been noticed. From this it has been affirmed that it arises from over-feeding, or that it has been produced by the over-distention of the stomach. But it is also believed to consist in a peculiar state of the stomach previous to this inordinate repletion from which the morbid appetite has originated. Be this, however, as it may, it is certain that the disease is usually fatal in its termination; and if it really exist before repletion of the stomach takes place, it is usually in such a form as to escape observation. It is also certain that it is more general among horses that have had long fasts and been hard worked; and these seldom fail to fill themselves to satiety when an abundance of food is within their reach. Regular feeding would therefore appear to act as a prevention to the appearance of the disease.

Bleeding and physic are the remedies usually employed, and to this may be added back-raking and clysters. The disease is difficult to manage, the most skilful treatment being often unsuccessful.

Spasmodic colic, as the name implies, consists of violent and sometimes sudden spasms of the bowels, by which the most excruciating pain is produced. Sudden changes from heat to cold will produce this disease; for instance, the drinking of cold water when the horse is violently heated. It will sometimes follow exposure to cold air, or a cold wind after active exercise; and some horses seem constitutionally predisposed to colic, as they cannot be hard worked or exposed to unusual cold without a fit of it. It is of importance to distinguish between colic and inflammation of the bowels, for the symptoms have considerable resemblance, but the mode of treatment should be different.

The symptoms of colic are well known. The horse becomes very uneasy, paws his litter, looks round anxiously to his flanks, sometimes endeavours to kick his belly, gathers up his hind legs, and falls down rather suddenly, and, after rolling about, gets up as suddenly, appearing all the time to be in extreme pain. In a few minutes the pains will sometimes cease, and after shaking himself violently, the horse begins to feed; but, on a sudden, the spasms again return, probably with increased violence.

Spasmodic colic sometimes terminates in inflammation of the bowels, and the treatment of the disease should be directed to prevent this result. Bleeding is, therefore, generally adopted, not from any great influence it can have on the disease in question, but as having a tendency to prevent inflammation. Medicines are then resorted to, and the most powerful is turpentine, especially if given in conjunction with opium. Three ounces of oil of turpentine, with an ounce of laudanum, given in a pint of warm ale, will frequently have an almost instantaneous effect. If relief be not obtained in some time afterwards, half the quantity of these ingredients, wiih an ounce of Barbadoes aloes dissolved in warm water, may be given. The stimulus produced on the inner surface of the bowels by the purgative, may counteract the irritation which produced the spasm. The belly should be well rubbed with a brush or warm cloth, and the horse may be moderately exercised.

Inflammation of the bowels has been said to bear considerable resemblance to colic in its symptoms, and to be also frequently a termination of this disease. It is also frequently produced by similar causes; but it is sometimes the result of previous inflammation of the lungs, or of stones or other irritating substances finding their way into the intestinal canal. Unlike colic, it is generally gradual in its attack, with previous indications of fever, weak and quickened pulse, intense cold in the extremities, with constant and debilitating pain. Here there are no intervals of comparative repose, and motion, instead of affording relief, seems to increase the pain.

In all cases of inflammation the treatment must be prompt and energetic, as the disease is rapid in its progress, and bleeding is always the first and most powerful remedy. Blood is to be drawn until faintness is produced. As in the case of inflammation of the lungs, purgative medicines are to be used with extreme caution, the inner surface of the intestines being already in far too irritable a state to bear increased irritation without injury. Clysters of warm water, or very thin gruel, in which half a pound of Epsom salts or an ounce of aloes has been dissolved, should be copiously used. The horse may likewise be encouraged to drink plentifully of warm water or thin gruel;

and draughts, each containing a couple of drachms of aloes, may be given every six hours, until the bowels are freely opened.

Blistering is next to be resorted to for the reason already stated in treating of inflammation of the lungs, and the application should be as near as possible to the irritated parts. Friction and bandaging of the extremities will be necessary to restore the circulation to these parts, and the horse must be kept on the least stimulating diet until his recovery is completed.

Another species of inflammation of the bowels is produced by the too great action of violent purgatives, by which the inner coat of the intestines is subjected to great irritation. In this case the physic has been administered in undue quantity, or of an improper kind. The remedy would seem to consist in the liberal use of astringents, to counteract the tendency to such violent purging. Astringent medicines are, however, to be used at all times with extreme caution, as by too suddenly stopping the secretion of mucus, more violent inflammation might be produced. Gruel or arrow-root jelly, or some other light substance, should be administered in the first instance, both by the mouth and by clyster, and thus the irritation of the bowels will be lessened at the same time that the remains of the medicine are carried off. Should the purging and pain remain undiminished, chalk, catechu, and opium, are to be added to the gruel, in doses of an ounce of the first, a quarter ounce of the second, and two scruples of the last, and repeated at intervals of six or eight hours. The quantity of the astringent medicine should be gradually lessened as the purging begins to subside. Bleeding will rarely be necessary, unless the inflammation be very great, and attended by symptoms of general fever. The horse should be warmly clothed, and placed in a warm stable, and his legs should be hand-rubbed and bandaged.

Worms of different kinds make their way into the intestines; but except when they exist in very great numbers, they are not so injurious as is generally imagined. Their origin and mode of propagation do not seem to be well understood. Various substances are employed as vermifuges; but when the horse can be spared from work, perhaps the safest is a strong dose of physic.

4. *Diseases of the Extremities.*

Strain of the Shoulder. Shoulder strains are very rare, most of the lamenesses attributed to the shoulder belonging to some other part, and especially to the feet. In some violent and unexpected shock, however, the muscles of the shoulder may be occasionally injured, and this is effected oftener by a slip or side fall than by fair, though violent, exertion. When a strain of the shoulder takes place, the horse will suffer extreme pain in moving, the muscle underneath will be inflamed and tender, he will extend the leg as little as possible, and, in the effort of doing so, he will drag his toe along the ground.

In strain of the internal muscles of the shoulder, few local measures can be adopted. When the injury is recent, the horse should be bled from the plate vein, or vein on the inside of the arm, the blood being in this case abstracted immediately from the inflamed part. A dose of physic may be given, and fomentations applied to the part, the horse being, in the meantime, kept as quiet as possible. The injury is too deeply seated for external stimulants to have any considerable effect, yet a blister will be very properly resorted to, if the lameness is not speedily removed.

Broken Knees. The usual cases of broken knees are referrible to wounds in general; and the treatment of them, when the injury is slight, is in no wise different therefrom, unless that greater pains are necessary to effect a cure without a blemish remaining on the part. When, however, the injury extends to the ligament of the joint, and this part is ruptured, it becomes of quite a different character, and requires the most skilful treatment to effect a cure.

In the treatment of broken knees, the first thing to be done is, by careful washing with warm water, to cleanse the wound from all gravel and dirt which may remain in it after the fall. It must then be ascertained whether the joint is penetrated. Should the capsular ligament be found injured, and the synovia, or joint oil, in the form of a yellowish transparent fluid, escaping from the joint, the first and immediate care must be to close the orifice; for the fluid which separated and lubricated the joints of the knee being suffered to flow out, they will be brought into actual contact with each other, and by the friction thus necessarily produced, the membrane by which they are covered will become highly inflamed. If this be continued for any considerable time, the constitution will be affected, and a degree of fever brought on which will eventually destroy the horse.

The mode of closing the opening must alone be determined by the actual circumstances of the case. It may be effected by a compress enclosing the whole of the wound, and not to be removed for many days; or it may be attempted by the old and generally successful method of applying the hot iron over the wound, and, particularly, over the spot where the ligament appears to be lacerated. A poultice may then be placed on the part, and the case treated as a common wound. Should the joint oil continue to flow, the iron may be applied a second or even a third time. By the application of the iron, so much swelling is produced on the immediate puncture and in the adjacent parts, as mechanically to close the orifice. Injections of caustic substances into the wound cannot be too much reprobated, as being not only altogether useless, but as inflicting the most excruciating pain which can possibly be endured.

After the application of the iron, a pledget of tow, dipped in friar's balsam, is to be placed over the part and bound by a calico bandage with considerable tightness, and this not to be removed for a week unless a great degree of swelling takes place, in which case an attempt is again to be made to close the opening, the bandage being applied the same as before. A second or third removal of the bandage will enable the operator to ascertain whether a cure is likely to be effected; and he should recollect that although a fair chance of success will justify him in resorting to measures even so severe as those that have been recommended, nothing will excuse his prolonging torture when hope is fled. Humanity in this case will dictate that the animal should be destroyed.

Should the process be successful, and the wound be healed, some degree of blemish will necessarily remain, which will be best removed by the application of a mild blister. This will stimulate the hair to grow, especially hair of the natural colour.

Splint. This is a bony excrescence of the fore-legs invariably found on the outside of the small bone, and on the inside of the leg. The horse often becomes lame during the formation of a splint; but that state of the bone which causes the lameness seldom continues long, nor does it ever produce permanent lameness, unless the splint be in a situation in which it interferes with some tendon or ligament, or in the immediate vicinity of a joint. Remedial measures are seldom employed in the case of splints, and they are altogether useless unless at the commencement of their formation. At this time the hair should be closely shaved off around the part; a little strong mercurial ointment rubbed in, which is to be followed by an active blister. Should it resist these applications, the cautery may be resorted to; but it is seldom advisable to go thus far, unless the splint interferes materially with the action of the suspensory ligament.

Strain of the back Sinews. This is generally an injury done to the sheaths of the tendons, or of the ligaments which bind them down. It is generally confined to inflammation of the sheath, or rupture of the attaching fibres. The inflammation of the part is, however, often very great, the pain intense, and the lameness excessive. The symptoms are swelling, heat, and tenderness, and a proportionate degree of lameness.

In every serious affection of this kind, care should be taken that the local inflammation does not produce general disturbance of the system; and, therefore, the horse should be bled and physicked. The bleeding may be at the toe, by which an important local, as well as general, effect will be produced. The leg is afterwards to be well fomented with warm water two or three times a day, and half an hour at each time; and, between the fomentations, the leg should be inclosed in a poultice of linseed-meal. The inflammation being subdued, the part is to be bandaged tightly for some days; and if the bandage be soaked in a mixture of vinegar and spirit of wine, it will further serve to guard against a recurrence of inflammation. Should lameness or any considerable enlargement of the part remain, a blister may be applied.

Strain of the ligaments of the fetlock and coffin joint often occurs, and sometimes becomes a very serious affair, not being always attended by any external swelling; and being detected only by heat round the coronet, the seat of lameness is often overlooked, and the disease is suffered to become confirmed before its nature is discovered. The treatment is the same as that recommended for strains of the back sinews.

Ringbone is a bony excrescence formed around the coronet, which sometimes produces very considerable lameness. It usually commences about the pastern joint, and involves not only the pastern bones, but also the cartilages of the foot. When the first deposit is on the lower pastern, and on both sides of it, and produced by violent inflammation of the ligaments of the joints, it is recognized by a slight enlargement, or bony tumour, on each side of the foot, and just above the coronet. This is more frequent in the hind foot, the pasterns of it being more subject to ligamentary injury. In the early stage of the disease, an attempt may be made to remove it by blistering, or by the application of the cautery, which is not always unsuccessful. The degree of lameness occasioned by it depends on the situation of the enlarged part with respect to the joint. If it occurs upon the centre of the bone, it often proves harmless; but if on the margin of the joint, it usually produces lameness which is incurable.

Curb is an enlargement at the back of the hock, about three or four inches below the point of it, and is produced by inflammation of the ligaments of the joint. It is usually accompanied by considerable lameness at its first appearance, but the swelling is not always great. Indeed, it sometimes presents so gradual a curve, that it is scarcely perceivable when viewed from behind.

In the treatment of curb the object is to abate the inflammation, by the application of cold, evaporating lotions, frequently repeated. Equal portions of spirit of wine, water, and vinegar, will make an excellent lotion for the purpose. If the heat and lameness are considerable, it may be necessary to bleed and physic, and apply a blister. The blister must be repeated until the swelling disappears.

Bog Spavin. This is an enlargement of the larger vein passing along the hock, partly occasioned by an increased capacity of the vein itself at the part, and, often, partly from the formation of tumours beneath it, which, of course, make it project considerably. These tumours are produced by the rupture or distention of the membranes which form the synovial cavity, and these often materially interrupt the circulation in the large vein mentioned. The consequence is, the formation of a swelling, which is soft and yields to pressure, but rises again as soon as the pressure is removed. This is a very serious disease, attended with no great, but often permanent lameness, and usually returns after being apparently subdued. It is a consequence of over-exertion, by which the ligaments of the hock have been injured.

This disease is removed with difficulty, the injury being deep-seated. Unless in desperate cases, it is scarcely worth attempting a cure. The only remedy consists in active blistering, by which such a degree of external inflammation is excited, as may tend to remove the enlargement, but even this mode of treatment is seldom successful.

Bone Spavin. This is a still more formidable disease. It is closely allied to splint, being an enlargement of the bony matter of the hock, produced by previous inflammation of the ligaments of the part. During the formation of this bony excrescence there is always lameness, and that frequently to a very great degree; but when the membrane of the bone has accommodated itself to the tumour that extended it, the lameness subsides, or disappears, according to the degree in which tbe bony deposit interferes with the motion of the joint. The only remedy consists in blistering, which, at an early stage, will usually effect a cure. The obsolete practice of removing the excrescence by a chisel and mallet, is generally injurious to the horse, and opposed to the dictates of humanity.

Spavin of either sort invariably produces a greater or less degree of lameness at intervals, but the animal is not by any means rendered incapable of performing any sort of work in which quick action is not required. A spavined horse is not only capable of ordinary farm work, but he also generally improves at it, becomes less lame, and the tumour even seems to be diminished. For fast work, however, he is altogether unsuited.

Swelled Legs. This is a frequent and most troublesome complaint. The cause is often difficult of detection, and frequently exceedingly complicated. The hind legs are more disposed to swell than the fore legs. Even when no other disease appears to be present, the legs all at once suddenly swell to an enormous degree, attended by heat and extreme tenderness of the skin, and excessive lameness. This is evidently sudden and very intense inflammation of the absorbents of the leg. A considerable degree of fever generally follows. Want of proper exercise and high feeding are usually causes, but sometimes it is brought on by over-exertion. Sometimes it is caused by inflammation shifting from some other part, as the lungs or the intestines.

Moderate exercise is the chief remedy, as, removing the cause, it soon effects a cure. Friction, by hand rubbing, is an excellent mean of allaying the inflammation, especially if assisted by bandages, which also have an admirable effect. These are always to be used in the first instance, and it is only in the event of their failure that medicines are to be used. Aperient and diuretic medicines are those employed, but in a disease evidently proceeding from general debility, they should be sparingly administered.

Grease. Swelled legs, although distinct from grease, are apt to degenerate into it; therefore this disease comes next under consideration. It is an inflammation of the skin of the heel, sometimes of the fore, but oftener of the hind feet. Of all the diseases to which the horse is subject, there is none more peculiarly attributable to bad management than grease, as it never makes its appearance where an opposite mode of proceeding is adopted. Every thing that has a tendency to excite inflammation in the skin of the heel is a cause of grease. Want of exercise, is therefore a frequent cause. When high feeding is added to irregular or deficient exercise, and want of cleanliness in the stable, this disease is still more likely to be produced.

The treatment of grease is simple if taken in time. On the first appearance of the disease the heels should be washed with soap and water, and afterwards rubbed with ointment composed of sugar of lead, in the proportion of a drachm to an ounce of lard. This will generally heal the part unless the disease has proceeded so far that cracks appear, with a discharge from the heels. In this case a poultice of linseed meal, with charcoal added, may be applied, and when the discharge assumes a healthy appearance a dressing of ointment, composed of one part of resin, three of lard, and one of calamine powder, will usually effect a cure. A diuretic may be given, but a mild dose of physic will be preferable.

Acute Founder of the Foot is a very formidable disease, and of frequent occurrence. It consists of inflammation of the sensible laminæ or fleshy plates, on the front and sides of the coffin bone, occasioned by over-exertion or sudden alternations of temperature in the foot. Although seemingly little understood, the disease can rarely be mistaken. Considerable lameness will be evinced, and if the feet be examined they will be found evidently hot; the horse will express pain if they are slightly rapped with a hammer, and the artery at the pastern will throb violently.

The treatment will resemble that of inflammation generally. Bleeding is indispensable, and the toe vein should be selected for the operation, as producing a much greater local effect. After this, poultices of linseed meal should be applied, so as to cover the whole of the foot and pastern, and be frequently removed. The effect of the poultices will be increased by the removal of the shoe, and paring the sole as thin as possible; but this must be done with extreme caution, the pain of the part being intense. Should no amendment be observed, the bleeding may be renewed on the following day, and in a day or two afterwards a blister may be applied, the horse being kept, in the mean time, on mash diet or other food little stimulating in its nature.

Pumiced Feet. The pumiced foot is a very common consequence of acute founder, in which, the elasticity of the laminæ becoming destroyed, the support of the coffin-bone is removed, and it rests wholly on the sole, which thereby becomes flattened, or even convex, by this unnatural weight. It sometimes occurs without previous inflammation, especially in horses with large, wide feet. This is a disease for which there is no remedy, all treatment being merely palliative. If the projection be not too great, a thick bar shoe is the best thing that can be applied; but should the sole have much much descended, a shoe with a very wide web, bevelled off so as not to press on the part, may be used.

Contraction of the Hoof. The artificial life that horses lead subjects them to many diseases unknown in their natural state, and one of these is contraction of the hoof. This affection is generally slow in its progress, but gradually the foot increases in length and narrows in the quarters, and particularly at the heel; the frog is diminished in width, the sole becomes more concave, the heels higher, and lameness, or at least a short and feeling action, ensues.

In the case of contraction of the hoof, prevention is better than cure; indeed the latter is rarely effected, and the propriety of attempting it is extremely questionable. It is often not so formidable as is generally represented, and many horses with a slight degree of contraction in the hoof, continue to perform their work without difficulty, and do not evince any considerable degree of lameness. Contraction tends to produce lameness, but the process being slow and gradual, some of the other parts become extended, so that it is more a change of form than of capacity; for as the foot becomes narrow so it increases in length.

Contraction is frequently the consequence of neglecting to pare the hoof, by which it increases to an undue size, and destroys that expansion which it would otherwise possess. It is, therefore, mistaken economy to allow shoes to remain for a great length of time on the feet, as this circumstance unquestionably contributes to the disease. Another source is the want of natural moisture, and hence the propriety of stopping the feet of horses standing in the stable. Defective management may also lead to contraction, as high feeding, and want of regular and moderate exercise.

Sand Crack. This is a crack or fissure in the side or quarter of the hoof, generally on the inside, and almost always in the fore-feet. When it occurs in the hind-feet it is generally found in the front, and in either case lameness is produced. Sand crack is indeed a most serious defect. It indicates a brittleness of the crust, sometimes natural, but oftener the consequence of mismanagement or disease, which, in defiance of every means adopted, will probably be the source of future annoyance.

In the treatment of sand crack it is first necessary to ascertain the extent of the injury, and to remove any foreign matter that may have got into it. The edges of the crack are then to be thinned down, and any formation of matter within it may be removed by the application of butyr of antimony. The firing-iron is then to be applied both above and below, to prevent the extension of the injury; after which a pledget of dry tow should be placed in the crack and another over it, the whole being bound up as tightly as possible.

Punctures or Wounds in the Feet. These are often very serious evils, either when received by nails in shoeing, or by some instrument come into contact with on the road. The danger arises from the inflammation, which is always great from any injury done to the sensible and vascular parts within the foot. This inflammation quickly proceeds to suppuration, and the matter thus formed will spread and greatly injure the other parts of the foot, unless it find a ready vent from the sole.

Sometimes a horse is lame from puncture of the feet, when no apparent opening can be seen by which the cause of injury could have entered. After due examination of the other parts, it will therefore be good policy to have the shoe removed, and if the seat of injury be not denoted by the heat of the part, it will be ascertained by rapping the crust all round with the hammer or pressing it with the pincers, and, in either case, the flinching of the animal will quickly discover it. When the seat of mischief is ascertained, the sole should be thinned round it, and, especially at the hole or puncture, it should be pared to the quick. The escape of some matter will now probably tell the nature of the injury. The opening must be enlarged, and the case treated as an ordinary wound.

In removing the shoes in the case of wounds in the feet, and in fastening them on again, great caution should be observed, as, by rough and unfeeling treatment, the injury may be increased. Before removing the shoe the nails should be drawn separately, instead of wrenching it off at once, to the manifest injury of the foot. If the injury has been inflicted by any of the nails in shoeing, it will perhaps be detected by examining them separately as they are drawn.

Thrush is a disease of the frog, causing a discharge of offensive matter from its division or cleft, and is attended by considerable tenderness of the part, and sometimes of the whole foot. In the hind-feet it usually proceeds from defective stable management, and in the fore-feet it is often caused by contraction. It is not always accompanied by lameness, and in a great many cases the appearance of the foot is scarcely or not at all altered, and the disease can only be detected by close examination.

The treatment of thrush will depend, in some degree, on the cause by which it has been produced. When occasioned by filthiness, the cause must be removed, and then the disorder may cease; but this is not always the case, for the thrush sometimes has proceeded so far as to produce ulceration of the sensible frog, which will require the application of astringent medicines to effect a cure. A paste, composed of two ounces of blue and one of white vitriol, powdered as finely as possible, and rubbed down with one pound of tar and two of lard, applied to the part, will effectually and speedily dry up the discharge.

Quitter and canker are generally the result of punctures or thrushes when neglected or originally extensive. These are extremely difficult of cure, but they are prevented by removing the exciting causes.

IV.—VETERINARY OPERATIONS.

It is essential that the farmer and every one interested in the management of horses should become acquainted with the mode of performing the principal operations which are necessary, either as tending to make the animal accommodate himself still more to his artificial state of life, or as counteracting the injurious effects of disease. The performance of them will, indeed, more properly belong to the veterinary practitioner, unless upon urgent occasions; but this does not at all interfere with the propriety of the owner being able to ascertain whether or not they are properly performed, and also of being able to operate himself in the less difficult cases, in the event of no other assistance being within reach.

In the performance of surgical operations it is frequently necessary to bind the human patient; it is, therefore, more necessary to bind the horse, who is not under the control of reason, and whose struggles may not only be injurious to himself but dangerous to the operator, and interfere materially with the execution of the operation.

Confinement by the side-line is a very simple and useful method of putting a horse under restraint, and places him in sufficient subjection for the operations of docking, nicking, and firing. A long rope, with a noose at one end, is fastened on the pastern of one of the hind-legs. The rope is then brought over the neck and round the withers, and then tied to the portion that comes from the leg. The leg may thus be drawn so far forward that, while the horse cannot evidently kick with that leg, he is disarmed of the other, for he would not have sufficient support under him if he attempted to raise it. Neither can he easily use his fore-legs, or, if he attempt to use them, one of them may be lifted up, by which he will be rendered nearly powerless.

With the aid of active assistants, this mode of confinement will be sufficient for the performance of almost any operation, with the exception of castration; and it must be remembered, that the casting of horses is generally attended with bad consequences, in a greater or less degree, to the animals, therefore it is only to be resorted to as a last resource.

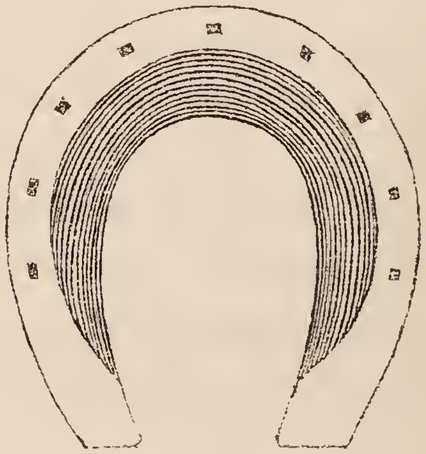
It is necessary, however, that the animal should be thrown for castration, and perhaps also for severe firing. This is performed by means of what are termed hobbles, the construction of which is generally known to horsemen. They consist of strong leather straps and buckles, one of which is buckled around each pastern, and from the strap a large iron ring extends. The end of the rope being fastened to one of these, and drawn through the remainder, the assistants take hold of the other end, and easily pull the horse off his feet.

As a minor method of restraint, but sufficient for many purposes, the twitch may be mentioned. This consists of a noose passed through a hole at the end of a strong stick, and in this noose the muzzle is enclosed. The stick being turned round twists the noose, and consequently diminishes its capacity, thereby securely retaining the muzzle, while the horse suffers great pain from the pressure—sufficiently great to prevent him from making any attempt to struggle, for every motion increases the pain produced by the twitch.

Shoeing. The importance of the subject of shoeing is sufficiently attested by the immense number of inventions which the ingenuity of artists is every day devising to render the system complete. The shoe is an unnecessary appendage to the horse in his natural state, but it is absolutely necessary as a protection while engaged in the numerous services which are now required of him. The diseases of the feet are numerous, and many of them have been traced to bad shoeing; indeed, shoeing is said to be conducive to disease, even when performed in the best manner. The proper form and construction of the shoe are, therefore, deserving of attention; for it is most important to ascertain the kind of shoe that will do the least mischief to the feet.

The annexed figure represents a shoe of a construction which has been much recommended. It presents a perfectly flat surface to the ground, to give as many points of bearing as possible, except that around the outer edge there is a groove, in which the nail holes are punched, so that, sinking into the grove their heads project but a little way, and are soon worn down level with the shoe. The web of the shoe is of the same thickness throughout, from the toe to the heel; and it is sufficiently wide

Fig. 82.



to guard the sole from bruises, and as wide at the heel as the frog will permit, in order to cover the seat of corns. The outer part of it is flat, and of the width of the crust, and designed to support the crust only, for it is on this part alone that the weight of the horse should be supported. Towards the heel, this flattened part is wider, and occupies the whole breadth of the web, to support the heel of the crust and its reflected part, the bar; thus, while it defends the horn included within this angle from injury, it gives that equal pressure upon the bar and crust which is the best preventative against corns, and a powerful obstacle to contraction.

It is fastened to the foot by nine nails, five on the outside, and four on the inside of the shoe; those on the outside extending a little farther down towards the heel, because the outside heel is thicker and stronger, and there is more crust to hold the nails; the last nail in the inner quarter being further from the heel, on account of the weakness of that quarter. The inside part of the web is bevelled off, or rendered concave, that it may not press upon the sole, and thereby interfere with its elasticity. This form is also better calculated to facilitate the removal of gravel or small stones between the crust and the shoe than if the latter were flat, as these matters would in this case necessarily be retained, and almost bid defiance even to mechanical force for their removal.

The proper preparation of the foot for the application of the shoe is also an important operation. Many feet are injured by the rough and careless manner in which the old shoes are removed, the crust of the hoof being often torn, and thereby rendered less capable of affording a sufficient hold for the retention of the shoe afterwards. Before attempting the removal of the shoe, the points of the nails which were previously turned down, should in every case be raised, an operation which is often altogether neglected, or very imperfectly performed. The shoe being removed, the rough edges of the crust are rasped off, after which the sole should be pared throughout, until a strong pressure with the thumb can produce some yielding, or show a sensible degree of elasticity in the lower part of the foot; and in this paring, the natural arch of the sole should be imitated as much as possible. This paring of the foot is absolutely indispensable to insure healthy action; for when an undue portion of horn is allowed to accumulate, the elasticity of the sole is destroyed, the functions of the foot are impeded, and a foundation is laid for corns, contraction, and inflammation.

The quantity of horn to be removed, in order to leave the remaining part of the proper thickness, will vary in different feet, and will also depend much on previous treatment. From the strong foot a great deal must be taken. From the concave foot the horn is to be removed, until the elasticity of the sole is ascertained by a strong pressure of the thumb. From the flat foot little need be pared; while the pumiced foot will spare nothing but the ragged parts. In paring, the crust must be reduced to a perfect level all round, but left a little higher than the sole.

Of the manner of attaching the shoe to the foot, the owner can scarcely be supposed to be a competent judge; he can only take care that the shoe itself shall not be heavier than the work requires; that for work a little hard the shoe shall still be light, with a bit of steel welded into the toe; that the nails shall be as small, as few, and as far from the heels, as may be consistent with the security of the shoe; and that, for light work at least, the shoe shall not be driven on as closely and as firmly as it is often done, to the great injury of the foot.

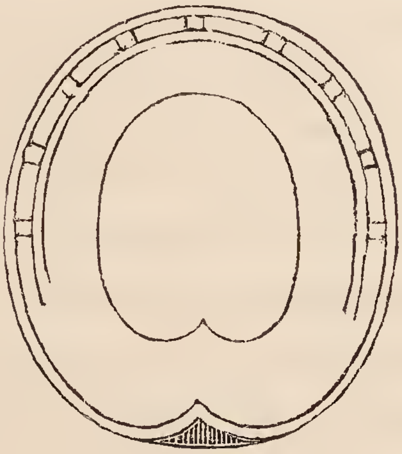
Clips on the toes are becoming very common. These are portions of the upper edge of the shoe, hammered out and turned up, so as to embrace the lower part of the crust, which is usually paired out a little to receive the clip. They are very useful, as more securely attaching the shoe to the foot, and relieving the crust from that stress upon the nails which would otherwise be injurious. A clip at the toe is almost necessary in every draught horse, to prevent the shoe from being loosened or torn off by the stress which is thrown upon the toe in the act of drawing.

The shoes for the hind-feet are somewhat different from those for the fore-feet. In forming the hind shoes, it should be remembered that the hind limbs are the principal instruments in progression, and that, in active motion or heavy draught, the toe is the point on which the whole frame of the animal turns, and from which it is propelled. The shape of the foot itself is somewhat different, being straighter in the quarters, and to this peculiarity the shoe must be adapted. The nails in the hinder shoe may be placed nearer to the heel than in the fore shoe, because, from the comparative little weight and concussion thrown on the hind-feet, there is not so much danger of contraction.

The propriety of using calkins of the enormous height they are generally made, is extremely questionable. They tend to interfere with the equal pressure of the several parts of the foot, especially when they are not of an uniform height. They are more necessary on the hind feet as enabling the animal more effectually to dig his toe into the ground to propel himself forward in heavy draught. When they are used, it is especially important that they be of the same height, otherwise the horse will be walking on one side of his foot, and incurable lameness may be produced.

The shoe will vary in substance and weight with the conformation of the foot and nature of the work. But, under peculiar circumstances, shoes of other forms may be used, such as when any part of the foot is diseased or otherwise injured. In this respect the *bar shoe* is a very useful contrivance; and it is to be regretted that so much prejudice prevails against the use of this shoe, which can only arise from its supposed unsightly appearance, as betokening unsoundness. As a defence to weak, thin feet, it is invaluable, as it removes a part of the pressure from the heels and quarters to the frog. It is a continuation of the common shoe round the heels, as represented in the figure. It is evidently not safe in frosty weather, or when much speed is required of the horse.

Fig. 83.



When horses are put to grass, it is necessary to take off the shoes, in order that any tendency to contraction in the feet may be lessened or removed, and to prevent them from injuring each other either through playfulness or vice. In this case *tips,* reaching only half round the feet, are worn, to prevent the crust being torn by the occasional hardness of the ground, or by the pawing of the animal; and the quarters at the same time being free, the foot disposed to contract has a chance of expanding and regaining its natural shape.

Bleeding. This is a very common, and, to the horse, important operation. It is of the greatest importance in all acute or rapid diseases, and more especially in this animal, because his inflammatory diseases, on account of the great strength of his arterial system, soon run to a fatal termination, and can only be checked in the rapidity of their progress by abstracting blood, which diminishes the momentum of circulation. In colds and inflammations generally, it is always required, and is the principal remedy that can be applied.

As to the situation and manner of performing the operation, it may be observed that bleeding is either local or general. By general bleeding it is meant that a quantity is drawn from some large vein sufficient to affect the system. Nor is it a matter of great importance which vein may be fixed upon for the operation. Any of the large veins may be opened for a general bleeding with the same success, but the most convenient are the jugular veins, or veins of the neck, the cephalic, or veins of the arm, and the saphœna, or veins of the thigh. In local bleeding, the vein to be opened depends on the seat of the injury or inflammation, which it is intended that the operation should counteract or remove.

Having fixed upon the vein for the operation, the next thing to be attended to is the instrument, of which there are several sorts, as lancets and fleams. Most expert practitioners use a lancet to bleed with; and when the habit of using it is acquired, it is decidedly the most workmanlike instrument. The fleam is, however, more commonly employed, and in unskilful hands is much safer. As an accompaniment to the fleam, a bloodstick is required, which consists of a hard piece of wood, loaded at the end with lead, to strike the fleam into the wound. It is preferable to the lancet, in being more certain in the extent of the wound made by it; for all that is necessary to complete the operation with the fleam is, to place the star of the instrument fairly upon the part in the line of the vein, and to give a sufficient blow with the bloodstick. The blunt part, or blade of the fleam, prevents it from going too deep, and the size of the star insures a sufficient opening.

In proceeding to the operation, the first step is to prevent the returning flow of the blood, so that the vein may become better filled, and more easily struck. This is done in the neck of the horse, by pressing with the finger on the course of the vein, below the part where the wound is to be made; but the pressure must not be too great, for then the vein would present a surface too much rounded, and the instrument would be extremely liable to slip over it. The fleam is to be placed in a direct line with the course of the vein, and over the centre of it, and a good blow with the bloodstick will cause a flow of blood. A sharp stroke should be given, for there is little danger of the fleam doing injury, the blade being a sufficient guard to prevent it from going too deep. When it happens that the first blow fails to cut the vein, it must be repeated, care being taken to place the instrument in the external opening, and in such a direction as to be fair on the centre of the vein, the neglect of which has been the cause of the former failure. The pressure on the vein being removed when a sufficient quantity has been drawn, the blood will cease to flow, and the opening may be closed up. The usual mode of doing this consists in bringing the edges of the wound together, and passing a pin through them, around which a few hairs from the mane of the horse may be wrapped, to prevent the effusion of blood. Should the operation be performed with a sharp and clean instrument, the wound may, however, be closed by merely bringing the edges of the wound into contact, and holding them so by the hand for a short time, after which they will remain in the desired position themselves, and a fruitful source of inflammation of the vein will thus be avoided. In either case the head of the horse should be tied up for several hours, to prevent his rubbing the part against the manger to renew the bleeding of the wound.

Blistering. The principle on which blisters act has been said to be this:—that no two intense inflammations can exist in neighbouring parts, or, perhaps, in the system, at the same time, without being influenced by each other. Hence the propriety of applying stimulating acrimonious substances to the skin, to excite external inflammation, and to lessen or draw away inflammation in some deeper seated and generally not far distant part. Thus, blisters are applied to the sides in inflammation of the lungs—to the belly, in that of the bowels—to the legs, in that of the cellular substance surrounding the sheaths of the tendons—and to the coronet, or the heel, in inflammation of the several parts of the foot. Blisters have likewise the property of increasing the activity of the neighbouring vessels. Thus, blisters are applied to bring the tumour of strangles more speedily to a head. They arouse the absorbents to energetic action, and take away tumours, and callous, and even bony substances.

The blister commonly employed is a mixture of Spanish flies, resin, and lard. The proportions are, one of flies, one of resin, and four of lard; the lard and resin being first melted together, and the powdered flies added afterwards. Mustard, made into paste with boiling water, and applied hot, will often form an excellent blister. Tincture of croton is sometimes applied as a liquid blister.

To ensure the active operation of the blister, the hair should be cut or shaved closely off, and the ointment well rubbed in. Some of the ointment may be smeared over the part after the rubbing, and the head of the horse must be tied up to prevent his nibbling the irritated parts, by which his muzzle would be affected, and often serious blemishes might be produced from the removal of any part of the skin off the place originally blistered. A contrivance called a *neck cradle*, will be found useful in preventing the animal from doing any injury to himself, as it prevents him from turning round his head.

Firing is employed on the same principle as the blister, and is designed, by producing superficial inflammation, to remove a deeper-seated one, or to excite the absorbents to take away any unnatural or bony tumour. Humanity, however, will dictate, that on account of the inflammation which it excites, and the pain which it inflicts, it should only be had recourse to when milder means have failed, except in those cases in which experience has shown that milder means rarely succeed. The operation is one which cannot, with safety, be performed without the assistance of a veterinary surgeon, and, therefore, the details of it need not be entered into here.

Setons are pieces of tape, or cord, passed by means of an instrument resembling a large needle, either through abscesses, or the base of ulcers with deep sinuses, or betwen the skin and the muscular, or other substances beneath. They are retained there by the ends being tied together, or by a knot at each end. The seton is moved in the wound twice or thrice in the day, and occasionally wetted with spirit of turpentine, or some acrid liquid, in order to increase the inflammation which it produces, or the discharge which is intended to be established.

Rowels. The action of rowels is similar to that of setons. The rowel consists of a piece of tow or leather, smeared with blistering ointment, and inserted into an opening previously formed for its reception. The skin being raised by the finger and thumb, a slit about an inch in length is cut in it to receive the rowel. Tow is to be preferred to leather for rowels, and if a part of it be left outside of the incision, it will serve to carry off the discharge. The tow should be changed every day, with or without the ointment, according to the action of the rowel, or the urgency of the case.

Docking consists in shortening the tail of the horse, and is an operation which fashion or caprice renders necessary. The length at which the tail is wished to remain being ascertained, an incision is made through it at the nearest joint, either by the docking machine, or by a large knife, the hair having been previously turned up, and tied round some distance above the cut. Considerable bleeding will now ensue, but it would rarely proceed so far as to be productive of injury, even were it not interfered with. Should it appear to continue, a red hot iron may be applied to the stump, which will completely stop the hæmorrhage; but care must be taken that the bone be not touched, as the application of the iron to it would be a source of much annoyance.

Nicking and *cropping* were much more common formerly than they are at present; and it is to be wished, that such barbarous practices were altogether done away with.

V.—THE REARING AND FEEDING OF HORSES.

The general principles of breeding have already been entered into at length, and need not again be recapitulated in this place. In the breeding of horses it is especially important that the parent of either sex should be free from disease, of the most perfect form, and of the variety which it is intended should be produced.

A mare is capable of breeding at three or four years old; but before that period, or, indeed, even then, her form and strength are not sufficiently developed. It is better that she should be four or five years old before being employed for this purpose. It happens often that mares are much older, being seldom selected for breeders until they are in the decline of life, or otherwise unable to execute their work. But an error may also be committed on the other side. When the animal is too old her energies are more or less impaired, and she becomes incapable of being used with advantage for the reproduction of the species.

The mare comes into season in the spring; she goes with young about eleven months, although with an irregularity, even to the extent of several weeks on either side. The most convenient time for her receiving the male is in May, that she may foal in April, when the herbage begins to spring. From the time she receives the male till that of foaling, the mare may be kept at moderate work, and that not only without injury, but with decided advantage. When nearly half the time of pregnancy has elapsed she should have a little better food. This is about the period when the slinking of the foal is liable to take place, and good feeding and moderate exercise will be the best preventative of this. If she has been regularly exercised, and apparently in health during pregnancy, little danger will attend the act of parturition.

After the mare has foaled she should be turned into a well-sheltered pasture, with a shed to which she may go at all times; and, in addition to the natural herbage, she should have an allowance of nourishing food, especially if she has foaled at an early period of the season, before the pastures afford a full bite. In about a month after foaling, she may again be put to moderate work. The foal will in this case be shut up for a time, during the hours of work, and after acquiring a little strength it may be allowed to follow the mare. It will thus become familiar with its attendant, and improve by exercising itself in play.

The mare will usually come into season at or before the expiration of a month, often, indeed, in a week or ten days after foaling, when, if she be kept chiefly for breeding, she may again receive the male. In five or six months, according to the growth of the foal, it may be weaned, which is done by merely separating it from the mare. The mother may then be put to harder work, and have drier food.

At the time of weaning, and during all the period of its growth, the foal should be liberally fed. Oats are seldom given to young horses, but the farmer will find that by allowing the foal a daily feed of bruised oats and bran, he wil be amply repaid in the rapid growth and superiority of the animal. It is essentially important, in the rearing of any description of live stock, that they should be well fed when young; but over-feeding and pampering are equally to be avoided. The proper place for the young colt will be a grass paddock, with a shed in which he can shelter himself from the inclemency of the weather. On the approach of winter he may be put into an open yard, having also a shed, and plentifully littered with straw. He may be fed on straw, with an occasional allowance of more nutritious food, during the early part of the winter, and as spring advances, on hay. But, although he is chiefly confined in the yard, it will be found useful to him to let him have a piece of ground to exercise in, in fine weather. As early in the spring as the pastures will allow, he is to be turned out to graze in the fields, where he is to be kept during the summer; and in the following winter put again into the yard or paddock, and treated in the same manner as before.

The process of breaking-in, or training the animal, may be commenced from the very period of weaning. The foal should be daily handled, partially dressed, accustomed to the halter, led about, and even tied up. The tractability, good temper, and value of the horse, depend on commencing the important business of training at an early period, a great deal more than is usually imagined. The kindest treatment should be invariably adopted, for the principle on which their after usefulness is founded is early attachment to, and confidence in man, and obedience, implicit obedience, resulting chiefly from these.

After the second winter the training may commence in good earnest. The colt may first be bitted, and a bit carefully selected that will not hurt his mouth, and of a smaller size than those commonly in use. With this he may be allowed to amuse himself, and to champ for an hour on a few successive days.

This treatment may be continued until the animal is become perfectly familiar with it from constant usage, and afterwards portions of the harness may be put on, always avoiding doing any thing calculated to frighten him. Successive portions of harness, including even a riding saddle, are to be put on as he becomes perfectly familiar with those previously used. At length he is taken out to the plough, or some other implement of draught, and is allowed to go forward for some time without any other obstacle to his progress than that which the implement to which he is attached opposes, until he becomes accustomed to the draught, and he will soon exert himself, and go along like the other horses, after which his load may be gradually increased.

As he becomes accustomed to his draught, he is to be taught to push back as well as to pull forward, and this, as in the former case, must be done without a load in the first instance.

By the adoption of these means little difficulty will, in general, be experienced in training the colt. The necessity of implicit obedience must, however, also be taught; but in doing so, much severity ought not to be practised, unless when absolutely indispensable. Punishment is not to be inflicted in such a manner as to excite the animal to resistance, but to convince him that we have the power to enforce submission. Few horses are naturally vicious. It is cruel usage which has first provoked resistance, and that resistance is continued or increased by the efforts made to subdue it. Correction may or must be used to enforce implicit obedience, after the education has proceeded to a certain extent, but the early lessons should be inculcated with kindness alone.

The same principles will apply to the training of the horse for the road or the chase. The handling and some portion of instruction should commence from the time of weaning, as the future tractability of the horse depends much upon this. At two years and half, or three years, the regular process of training should come on. If it be delayed until the animal is four years old, his strength and obstinacy will be more difficult to overcome. In the regular process, a headstall is put on the colt, and a cavesson affixed to it, with long reins. He is first accustomed to the rein, then led round a ring on soft ground, and at length mounted and taught his paces. Next to preserving the temper and docility of the horse, there is nothing of so much importance as to teach him every pace, and every part of his duty, distinctly and thoroughly. Each must constitute a separate, and sometimes long-continued lesson, and that taught by a person who will never suffer his passion to get the better of his discretion. Such a person only should be entrusted with the management of a horse at any period, or under any circumstances.

The male foal, unless when intended to be kept as a stallion, must be castrated; and the period at which this important operation will be best performed, depends much on the breed and form of the colt. When it is performed at an early age, as from five to ten months, it is generally attended with little danger to the animal, and the danger increases as he advances in age. It is better, however, that it should be delayed until the masculine form of the animal becomes fully developed.

For the reason just stated, it appears, then, that the colt should rarely be castrated before having attained the age of twelve months; and even then he should be carefully examined before the process is performed. If he is thin and spare about the neck and shoulders, and low in the withers, he will materially improve by remaining uncut other six months; but, if his fore-quarters are fairly developed at the age of a twelvemonth, the operation should not be delayed, lest he become heavy and gross before, and perhaps have begun too decidedly to have a will of his own. The operation should be performed rather late in the spring, or early in the autumn, when the air is temperate, and particularly when the weather is dry. The details of the operation must necessarily be left to an experienced practitioner.

The stable for the farm-horse, as for every other, should be spacious and well ventilated. Ventilation is necessary to afford a supply of pure air for the purpose of respiration, as well as for maintaining an equable temperature. It is not an uncommon practice, however, to have stables so closely shut up during the night, that, on first entering them in the morning, the atmosphere in them is so contaminated, that a person cannot enter them without the greatest inconvenience. It requires very little consideration, indeed, to see the impropriety of such an arrangement; for horses cannot possibly be healthy in such a situation.

Next to ventilation in importance is cleanliness. No filth should be allowed to accumulate, but every day the stables should be cleaned out with the utmost attention. Every portion of the litter that has been much wetted during the night should be removed in the morning, as the exhalation of the ammonia of the urine, retained by the litter, is very injurious to the eyes as well as to the lungs.

The food of the horse is different, according to the different situations in which he is placed. In this country, and in all temperate climates, it consists of herbage, grain, and roots, with, occasionally, mixtures of all three. The latter are becoming very general, and, when composed of proper ingredients, form, perhaps, the best food which can be given to horses.

Of herbage, the principal kind is the proper gramina, eaten either moist, or dried into hay. When eaten moist in their natural state, such a horse is said to graze; but when cut, and carried into the stable, the horse is said to be soiled. Hay is herbage cut during its flowering process; which, after being subjected to the sun and air a proper time, is collected into masses, in which a certain degree of fermentation takes place before the matter is fitted to become wholesome and nutritious food. The judicious management of the fermentative process forms one of the greatest desiderata in hay making. Pursued to a proper extent, the remaining moisture, acting on the farinaceous parts, in conjunction with the heat evolved during the process, as it were, malts the whole, and sugar is produced. Pushed beyond this, the hay becomes carbonized; its nutritive properties are lessened; and its noxious qualities increased, it being found in this state to contribute to the production of disease. The quality of the hay is of the greatest importance, especially when it forms the chief article of food.

Hay should never be given in large quantities at a time; for, independently of the want of economy attending the practice, the horse becomes disgusted with it after having breathed on it for some time. Neither should it be kept in large quantities in the stable, as, in that case, it will become impregnated with the ammonia, and other noxious vapours from the dung and urine, and thus be rendered extremely unpalatable. As a substitute for hay, the straw of the oat is sometimes used; but it is much less nutritive, and serves rather to excite mastication, by mixing it with other matters, than to be depended on for its nutritive properties. On hay alone many horses subsist; and when little exertion is required of them, they are sufficiently nourished by it.

The grain used as horse-food in this country is chiefly the oat, which, though deficient in nutriment, when compared with the others, is well adapted for the purpose. It is for the most part given to the horse without any previous preparation, though it is sometimes bruised, which is always beneficial, by rendering it more easily masticated and digested. The usual allowance for a feed of oats is a gallon, being the eighth part of a bushel, and weighing about five pounds.

Two gallons in the day, or ten pounds, are considered to be good feeding, when the horse is on dry food, and not hard work; when on hard work, the quantity may be increased to three gallons; and when on light work and green food, it is sometimes altogether withdrawn. But, on an average, two gallons in the day, that is, about ninety bushels in the year, will be sufficient, in every case, for the working horse of the farm. It is also the practice to give the horses the lighter oats; but, in this case, the quantity should be increased, as they are always deficient in nutriment. Oats may be given to horses reduced to a state of meal, but this is only practised in the case of gruel given to a sick horse. Meal is also sometimes given with cold water to horses while travelling, and this is a refreshing feed to a horse on a journey, when time is of importance, and when the horse, from fatigue or other causes, shows a disinclination to eat his oats.

Wheat and barley are seldom used as horse-food, although they contain much more nutriment than oats. The husk of wheat, known by the name of bran, is, however, much used in feeding horses. In some districts, a mash of boiled barley is employed, and, as well as that of bran, forms an excellent article of food; it keeps the bowels open, and is nutritive without being heating.

The pulse, used as horse-food, are the seeds of the bean and the pea. Beans form a valuable food for horses. The pea is similar in its feeding properties to the bean, and is, in a slight degree, more nutritive, without being so heating. Like the bean, it should always be bruised and given in mixtures. The quantity should be small, from a tendency which the pea has to swell and distend the stomach.

The roots used for the feeding of horses are such as contain much sugar, but in which the gluten is in small quantity. Carrots stand deservedly high on this list. The value of this root is not sufficiently known, whether as contributing to the strength and endurance of the healthy horse, or the rapid recovery of the sick one. In addition to their nutritive properties, they are favourable to what is termed condition, as the skin and hair always look well under their use. They have a beneficial effect on the lungs, and serve to remove coughs, and allay the symptoms of broken wind. The parsnip has similar properties. Swedish turnips, as having the saccharine principle in abundance, are also much esteemed. Beet and potatoes form good food, but inferior to those already mentioned.

Mixtures are formed of several kinds, and possess many advantages, as they can be varied to every taste, and made either cooling, as an alterative, or nutritious and stimulating, as a tonic. An excellent mixture is formed from a chaff made of one part best meadow and clover hay, and two parts wheaten straw; and to three bushels of this mixture add one of oats bruised. The importance of bruising the oats is very great. When used whole, either alone or with chaff, they are but very imperfectly masticated; and the entire quantity of nutriment which they are calculated to afford is not, in this case, obtained. A proportion of beans, peas, and roots, may be added, according to the labour which the animal has to perform.

When roots are largely used in the feeding of horses, it is important that they should be previously boiled or steamed. To horses with their digestive organs weakened by excessive exertion, or other causes, food in sufficient quantities, thus already reduced to a pultaceous mass, resembling chyme, without loss of time or waste of saliva, must be very important. The system of cooking roots, and using, them in conjunction with cut hay and straw, and bruised farinaceous seeds, is, indeed, one of the greatest improvements which have been effected in the feeding of any species of live stock.

The different seeds used as horse-food are bruised with facility, and the straw and hay easily cut into chaff, by machines similar to these figured in another part of this work, which may now be procured without difficulty. A prejudice exists against bruising the oats, on account of a supposed purgative quality which they are then said to possess, but this is altogether without foundation; and even did such quality exist, it would be corrected or neutralized by the astringent properties of the beans mixed with them. The mixture is relished by horses, and eaten more eagerly than oats in their whole and unmixed state; and the proportions of the ingredients may be varied to suit the work which the horse is required to perform.

When the straw and hay which are given to horses are cut into chaff, and mixed with one or more of the substances mentioned, the food is given in the manger, racks being in this case unnecessary. It is, indeed, to be wished that the latter were entirely discarded from the stables of the farmer, as they serve no good purpose, and occasion a great waste of food. When the system of manger-feeding is adopted, it is found that thirty pounds of food, including everything consumed by the animal, is sufficient for the largest sized cart-horses; but according to the common practice of placing large quantities of hay in the rack, more than this quantity of hay alone will be consumed, independently of the oats and other matters. An unlimited supply of food being, in this way, always before the horse, repletion often takes place; and when this is followed by immediate and violent exercise, broken wind and a long train of other diseases are engendered.

This mode of feeding farm-horses, then, appears attended with advantages of such an important nature, as to insure its almost universal adoption. In practising it, regard must be had rather to the weight of the several ingredients used than to the quantity as ascertained by measure, as grain, particularly, is found to be so different in quality; but any difference in this respect is much more likely to be counterbalanced when weight alone determines the quantities to be employed. About one-half may consist of chaff of equal quantities of straw and hay, one-fourth of bruised or coarsely ground grain, and one-fourth may consist of roots previously steamed. To this should be added about two ounces of common salt for each horse.

In determining what kind of food shall be given to the horse, and the precise quantity which shall be supplied, particular circumstances must often be allowed to operate. Violent and long-continued exertion, for example, will require the strongest food, and the largest allowance of it. But how much soever the daily allowance may vary, as regards the quantity of the several component parts, the aggregate will generally remain the same, and this will be about thirty pounds for even the largest farm-horses. At the period of active labour, the quantity of farinaceous matters must be increased, and some of the others lessened in a proportionate degree; and, under opposite circumstances, the reverse must take place. At certain seasons, indeed, the quantity of grain will be very small, or, perhaps, altogether dispensed with, that of the more nutritious roots being increased.

The times of feeding should be as equally divided as convenience will permit; and when it is likely that the horse will be kept longer than usual from home, an allowance of food should be carried with him. The small stomach of the horse is emptied in a few hours, and if he is suffered to remain hungry much beyond his accustomed time, he will afterwards devour his food so voraciously, as to distend the stomach, and endanger an attack of staggers. When extra work is required of him, the system of management is often injudicious; for a double feed is placed before him, and as soon as he has finished it, he is started. It would be much better to allow him a double feed on the previous evening, which will be digested before he is wanted, and then he may set out in the morning after a rather smaller allowance than usual, in preference to starting with a distended stomach.

The watering of horses is an important part of their management, a daily allowance of pure water being essential to health. In summer, or when, from great perspiration, the animal juices are wasted, it is of the last importance to ascertain that a sufficient supply has been given, as the want of it generates fevers, and wastes the health and spirits. All horses prefer soft water; and as nature is unerring, there is no doubt but that it is the most wholesome. Water should be regularly given three times a day, and in general the horse may be allowed to satisfy himself unrestrained, unless when violent exercise is to follow. It is especially important that a large allowance of water should not be given before starting on a journey, or immediately after it, while he is still warm.

The details of feeding farm-horses necessarily differ according to the different seasons of the year. During the summer they will be economically kept on green food, and during the remaining portion of the year, on a combination of the substances enumerated.

The supply of green food will begin to fail by the beginning of October, and the horses will then be put on harder food. The change of food should be gradually effected, and a full allowance of roots given at first, with about ten pounds of oats in the day to prevent the animal's falling off in condition. During the winter, when the hours of labour are diminished, a portion of the oats may be withdrawn, and straw may, in certain cases, be substituted for hay as provender, the full allowance of roots being still retained. As the length of the day increases in the spring, and the labour becomes severe, a proportionate increase in the allowance of oats must be made, which is to be continued until the labours of the spring are finished, after which the period of green feeding again commences. When the labour is not severe during the summer the allowance of oats is entirely withdrawn.

During the summer the horses are frequently turned out to the fields during the night, and in the interval of labour in the middle of the day supplied with cut green forage in the stable. In this case they must not be allowed to remain out at night after the middle of September, when the weather will be getting cold. The health of the animal is improved by this system, and a further improvement is effected by allowing them a turn at grass altogether, so long as they can be spared from work. They may also, however, be altogether confined to the house, receiving their allowance of green food there, and there is economy in this arrangement resulting from the accumulation of manure, and the saving of food which will be thereby effected ; but so far as regards the health and condition of the animals the preferable plan is to allow them to remain out on the grass.

In the practice of feeding farm-horses the utmost care must be taken that they never be allowed to get out of condition. In this case, not only are they unable to perform their work, but it requires a much greater expense to bring them again into order, than it would have required to keep them so. The leanness of a farmer's working stock, and their reluctant movements, but too clearly indicate his unprosperous condition. There are particular operations, indeed, which require to be executed with so great despatch in our variable climate, that unusual exertions are often indispensable. At these times it is hardly possible, by the richest food and the most careful treatment, to prevent the animals from losing flesh, sometimes even when their spirit and vigour are not perceptibly impaired. Such labours, however, do not continue long, and should always be followed by a corresponding period of indulgence. It is particularly dangerous and unprofitable to begin the spring labour with horses worn down by bad treatment during the winter.

In the stable management of farm-horses cleanliness is indispensable, not only as regards the state of the stable itself, but more particularly with respect to its occupants. The horse should be well brushed every morning, to remove scurf and other matters from among the hair, which interfere with the proper discharge of the functions of the skin. His feet should also be particularly examined before going to work, for the shoes may be loose, and the horse would consequently be stopped in his work. The appearance of disease will be more easily ascertained in the morning, and by its early detection the cure may be proportionably easy. When the horse is not naturally disposed to disease, and properly treated, it will, however, seldom make its appearance.

When the horse comes in at night, and after the harness has been taken off and put into its proper place, the heels should be well brushed out. Hand-rubbing will be preferable to washing, and this especially in the case of the farm-horse, whose heels, covered with long hair, can scarcely be dried again. If the dirt be suffered to accumulate in that long hair, the heels will become sore and diseased; and if the heels are washed, and particularly during the winter, disease will undoubtedly be the consequence of the coldness which is produced by the slow natural evaporation which afterwards takes place. The feet of the horse should never be washed without afterwards rubbing them dry, and the same precaution is to be adopted when they are wetted by other means. The foot should be carefully picked out and cleaned, and should the horse be allowed to remain in the stable from work, they should be stopped up to preserve the sole cool and elastic. But, before stopping, it is particularly necessary to run the picker round the whole of the foot, between the shoe and the sole, to detect any stone that may have insinuated itself there.

When horses come wet into the stable from the labours of the farm, the care of the horseman is not alone to be confined to the feet. They are to be rubbed all over without cessation until they are perfectly dry, for when allowed to remain until they become dry by evaporation, such a degree of coldness is produced in the animals as is extremely debilitating; and, when treated in this manner, it cannot be expected that they will be in what is termed condition, or fit to discharge the labours required of them.

Connected with the management of horses is the care of their harness. This is sometimes placed in a separate room, but the more usual practice is to place it behind the horses, the harness of each being placed behind himself, to prevent confusion. It is best kept in order by being rubbed and dried after being used, and if attention be paid to this there will be little trouble in the care of it. That part which presses upon the animals, the inside of collars for example, should be carefully dried before being used, as the harness itself is not only injured by neglecting this, but that part of the horse with which it comes in contact is often greatly inflamed by it.

It has been said that the horse is the only species of the genus to which he belongs that can be regarded as the especial subject of cultivation in this country. The ass, indeed, may occasionally be met with, but in his present state he cannot be regarded as deserving of the attention of the agriculturist. But a hybrid is produced by the union of the horse and the ass, greatly superior to the latter, and well calculated for the purposes of draught.

Animals which, by their union, produce fertile individuals, are generally said to be of the same species ; and the produce of animals of different species is, accordingly, said to be infertile. This rule was formerly much insisted on as a test of specific identity, there being extremely few exceptions to it. It appears, indeed, from the result of numerous experiments, that the generality of animals produced from a cross between even the most nearly allied species, are either altogether incapable of reproduction, or fertile in so slight a degree, that their descendants speedily become entirely sterile.

In order that a productive union may take place between animals of different species, it is necessary that they should belong to what naturalists call the same natural family. Thus the horse and the ass, the ass and the zebra, the quagga and the mare, when paired together, produce young. It is probable, however, that all these unions are so far forced and unnatural, that they never take place except through the influence of man, when domestication, and the numerous changes consequent upon it, have altered or impaired their natural instincts ; for it has been observed, that however education may perfect certain special qualities which man has the art to render subservient to his own convenience, yet a more extended view of the effects of domestication will convince us, that it is almost always to the disadvantage of the natural capacities that the brute creation is made to borrow the mask of human intelligence.

The common cultivated mule, then, being the produce of animals of different species, is incapable itself of propagation. Instances have sometimes occurred in which the reverse has been the case, but they are exceedingly rare. To make up for this in some degree, however, he lives much longer than either the horse or the ass, sometimes, indeed, to double their age.

Mules are sometimes produced by horses and she asses, but they are more frequently the produce of the jack-ass and the mare. The former are sometimes called hinnies, and are rarely met with, being less hardy than the mule, properly so called.

Mules are highly esteemed in the South of Europe as beasts of burden for either the pack or the saddle; but in this country they are chiefly used for draught. They are more hardy in constitution, more patient, and more muscular in proportion to their weight, than horses, and are also much less subject to disease. They are fed, too, at less expense, and when kindly treated and properly trained, they equal the horse in docility and obedience. In those countries where great attention is paid to the breed, the mule is as tall as the horse, and exceedingly well limbed, but not so handsome, especially about the head and tail.

Mules have not, hitherto, occupied much attention in this country, but it appears that they are deserving of cultivation were that discrimination exercised in the selection of parents which has been so sedulously practised in the breeding of horses. An important consideration in their favour is their being supported at much less expense than the horse, and performing, at the same time, an equal amount of labour.

XVII.—CATTLE.

I.—SPECIES AND VARIETIES.

THE term cattle is generally applied to the several species and varieties of the genus *Bos*, or the cow and ox kind. To few animals is man more indebted for important services than to the common ox, and none afford him so many articles of sustenance. Throughout a great part of the world its flesh is the principal article of animal food; while from the milk of the female, of itself an almost indispensable article of our diet, are manufactured cream, butter, and cheese. The skins furnish the greater part of the leather used in the arts. In short, there is scarcely any part of this valuable animal that is not useful to mankind. The bull and cow are also widely diffused, being inhabitants of most parts of the globe, and being everywhere partially domesticated. In most countries, however, they are the mere creatures of soil and climate, the same attention in breeding and rearing that is bestowed on the horse being withheld; the natural habits little restrained, or the form little improved for the purposes of milking, fattening, or labour. It is almost exclusively in the United Kingdom that this race of animals has been ameliorated, so as to present distinct varieties for each of these purposes far superior to what are to be found in any other country.

Cattle are, like most other animals, the creatures of education and circumstances. We educate them to give us milk, and to acquire flesh and fat, although there is little intelligence required for these purposes. It fares with the ox, as with all our other domesticated dependants, that when he has lost the wild freedom of the forest, and becomes the slave of man, without acquiring the privilege of being his friend, or receiving instruction from him, instinct languishes, without being replaced by the semblance of reason. But when we press him into our immediate service—when he draws our carts, and ploughs our lands—he rapidly improves in intelligence, and becomes quite a different animal.

Naturalists have enumerated eight species of the genus *Bos*, dispersed throughout the world, many of which bear little resemblance externally to our domestic ox, and have never been domesticated. Those which have been domesticated in this country are—

1. Bos bubalus—The common buffalo.
2. Bos taurus—The common domestic ox.

The buffalo is a native of India, from which it was brought into Egypt and Greece. It was introduced into Italy about the close of the sixth century; and numerous herds now graze among the Pontian marshes. It is used by the Italians as food, and as the beast of labour, and may be said to form the riches of the inhabitants of many parts of the country. The milk of the female is good, but the flesh is generally less esteemed than that of the domestic ox.

Although this animal seems well adapted for heavy draught, and has been occasionally employed for this purpose in England by several amateur agriculturists, it is not likely that it will ever become general. So far as regards the comparative docility of the buffalo, it does not appear that it would not be equally tractable with the common ox, were the same attention paid to training and rearing as has been bestowed on that animal; but this is not a property sufficiently important to cause the introduction of the buffalo into the agriculture of this country.

The varieties of our domestic cattle are innumerable. The pliancy of their nature is such, that they have been formed into many diversities of shape, and various qualities have been given to them very different from the original stock. In Lithuania the cows are almost as large as the elephant; while some of those on the Grampian hills are little above the size of a goat; and cows are found of every diversity of size between the one and the other. Nor are the qualities possessed by them less varied and diversified. The dairy-cow in this country is inactive and feeble, and scarcely capable of travelling from the stall to the pasture, when the distance is considerable; while those of Tartary are used as riding animals, and in drawing carriages. All these varieties of form and quality have been produced from the parent stock, partly by the diversity of soil and climate, or other accidental or adventitious circumstances, and partly, of late, by human skill and industry.

The origin of our different varieties of domestic cattle is not easily explained. The soil and climate of a certain district seem more favourable for the production and continuance of one variety than another; and many of our local varieties have, no doubt, originated from such peculiarities of soil and climate, aided by the intelligence and activity of those whose interest it became to encourage and improve the most advantageous sort. Certain special qualities are, from local or accidental circumstances, more valuable in one country or even county, than another; and these qualities are developed or decreased in proportion to the estimation in which they are held. Colour is too superficial a character to have any considerable influence on the natural or more substantial qualities of an animal; but it is easy to conceive that, when a breeder becomes possessed of a stock of cattle remarkable for combining the best and most desirable qualities, he will naturally attach some importance even to colour, though not an influential attribute; and that, other circumstances being the same, he will prefer to continue the breed from those which resemble the original and esteemed stock in colour, as well as in size, form, and proportions. It is probably in this way that the characteristic breed of each district is so often distinguished by a peculiar colour, from that even of a neighbouring province. It would, indeed, be impossible to account for it otherwise, for we cannot conceive that the different kinds of our domestic cattle sprung originally from different species of wild animals.*

From the earliest times, a distinguishing characteristic of the British farmer has been the excellence of his stock of cattle; and no little of the opulence of the country has been owing to this circumstance alone. It was not, however, until within a comparatively short space of time that the foundation of the several varieties of the present improved stock was laid; and by the exertions of a few individuals such splendid results have been attained, as to incite every one interested in the management of these animals to further exertions. The numerous varieties of cattle at present cultivated throughout the United Kingdom are greatly diversified, both by the different natural circumstances in which they are placed, and by the effects of art, in changing their properties and form. They are adapted to different situations, and for different purposes; but before entering on the comparative merits of each, it may here be inquired what constitutes the most perfect form for the different purposes for which they are reared.

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* Quarterly Journal of Agriculture.

In forming an opinion regarding the feeding qualities of an animal, several circumstances require to be taken into consideration. There is not only a peculiarity of form in the general structure, but the attention of the breeder is also to be directed to the different parts of the animal considered separately. To these parts the term *points* is technically applied; and, in familiar language, we often speak of the points by which live-stock are judged.

As a characteristic point of a good feeder, rotundity of form has been already mentioned. In the case of the horse, it was seen that the body, abstracted from the head and neck, is comprehended within a rectangle differing little from a square, the body occupying about the half of that rectangle. But, in the case of the ox, the body is comprehended within a rectangle differing considerably from a square, and the body occupies more than the half of that rectangle. The body of the ox, however, approaches to the rectangular form in other respects. It is found, the nearer the section of the carcass of a fat ox, taken longitudinally vertical, transversely vertical, and horizontally, approaches to a parallelogram, the greater quantity of flesh will it carry within the same measurement. That the carcass may fill up the parallelogram as well as its rounded form will permit, it should possess the following configuration:—The back should be straight from the top of the shoulder to the tail. The tail should fall perpendicularly from the line of the back. The buttocks and twist should be well filled out. The belly should be straight longitudinally, and round laterally, being well filled up at the flanks. The ribs should have a curved form, approaching to circular, and should project, as nearly as possible, horizontally, being at right angles to the bones of the spine. The hooks should be wide and flat, and from the tail to the hooks should also be flat and well filled. The loin-bones should be long, broad, flat, and well filled; but the space between the hooks and the short ribs should be rather short and well arched over with a thickness of beef between the hooks. A long hollow from the hooks to the short ribs indicates a weak constitution, and an indifferent thriver. These constitute the chief *points* which determine the relative value of an animal when fat, and the value of a lean one will depend on the probability of his realizing them when fed.

An essential point to be determined in judging of the feeding qualities of an animal is the nature of the bone. A round thick bone indicates both a slow feeder and the production of an inferior description of flesh. The whole bones of the carcass should bear a small proportion, in bulk and weight, to the flesh. Those of the head should be fine and clean, and only covered with skin and muscle. The neck should be small at the joining of the head, and it should also be short, as corresponding with the length of the limbs.

A full, clear, and prominent eye is another point to be considered; because it is a nice indication of good breeding, and is always an attendant on fine bone. The expression of the eye is an excellent index of many of the properties of cattle. A calm, complacent expression of eye and face, is strongly indicative of a sweet and patient disposition, and is invariably a certain characteristic of a kindly feeder.

The state of the skin is another point to be ascertained. It affords what is technically and emphatically called the *touch*—a criterion second to none, in the estimation of a perfect judge, in determining the feeding properties of an ox. That peculiar state of the skin, indicative of a kindly feeder, and a disposition to take on fat, is equally removed from that thick, firm skin, which is a characteristic of some varieties, and that soft, flabby skin, which denotes a weak constitution. A proper discrimination of this point is only acquired by long practice and careful observation.*

These, then, are the criteria by which the feeding properties of animals are ascertained; and they are not founded on mere arbitrary assumption, but are the result of the observation and experience of practical men. Those denoting good milking properties are similar in many respects; but, in general, the same rotundity of form is seldom advisable in an animal intended for the production of milk; and the hind-quarters should approach much nearer to the fore-quarters in size than is usually the case in fatting cattle. Good milking and fattening qualities are seldom combined in the same animal, only in a partial degree; and the efforts of breeders to produce this desirable result have as yet been, in a great degree, unsuccessful.

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* For further information on this subject we would refer the reader to a series of valuable papers in the Quarterly Journal of Agriculture, from the pen of Mr. Dickson of Edinburgh, to which we have been indebted on this and several other occasions.

These criteria of the most desirable properties of cattle being kept in view, we are now prepared to enter upon the comparative merits or defects of the different varieties, or, as they are more usually termed, *breeds*. The breeds of cattle are now become so numerous, that a variety can easily be procured suited to any situation; and the experience and judgment of the farmer will be exercised in selecting that breed which is suited to his particular case.

It will be sufficient to notice in this place those breeds of cattle only which are deservedly esteemed and worthy of cultivation, as a more extended notice of the several breeds of the United Kingdom would far exceed the limits assigned to this article. The horns being a striking characteristic of the breeds of cattle, they may be conveniently classed according to the comparative size of the horns. The short-horns, the middle-horns, and the long horns, shall therefore successively come under review. Besides these, several varieties of cattle are distinguished by the abscence of horns, being usually termed polled or hornless.

The short-horns deservedly stand at the head of the several breeds of cattle, as being unexampled in the possession of every quality which can enhance the value of this species of live-stock. The origin of the short-horns, like that of all other existing breeds of the country, is involved in obscurity, nothing certain being known concerning it. They are believed to be derived from Holland or Holstein, from the circumstance of the great similarity which exists between them and the cattle of these countries, and also from the fact of importations having taken place from this part of the Continent, which were supposed to have modified, if not changed, the characters of the native stock.

Applying the *points* of judging live-stock to the short horns, it is found, that for quantity and well laid on beef, the short horn ox is quite full in every valuable part. In regard to quality of beef, the fat bears a due and even preponderating proportion to the lean, the fibres of which are fine and well mixed, and even marbled with fat and abundantly juicy. The fine, thin, clean bones of the legs and head, with the soft, mellow touch of the skin, and the benign aspect of the eye, indicate in a remarkable degree the disposition to fatten; while the uniform colours of the skin, red or white, or both combined in various degrees, mark distinctly the purity of the blood.

During the last century, various individuals distinguishod themselves as breeders of the short-horns, and the variety was still farther improved. About the beginning of the present century, it had obtained a higher character, which it still continues to maintain. The short-horns are at once distinguished from any of the other breeds of the country by their additional size, and their more square and massy form. In applying the points already noticed to the short-horns, it would appear that they are perfect in form; their bones are exceedingly small, compared with the size of the animal; their skin possesses that peculiar touch so characteristic of a good feeder; they arrive early at maturity; and, further, they combine the valuable qualities of milking and fattening, in a degree unknown in the case of any other variety.

The prevailing colours of the short-horns are red or white, or a mixture of the two, combining in endless variety, and producing, very frequently, a most brilliant effect. The white, it is very probable, they obtained from an early cross with the wild breed; and whenever this colour shows itself, it is accompanied, more or less, with a red tinge on the extremity of the ear. No pure, improved short-horns are found of any other colours.

The size to which many of the short-horns have attained, and the enormous sums which they have produced, even at public sale, would, indeed, appear incredible to the Irish farmer, were it not that they are authenticated beyond the possibility of doubt. An ox of this breed, reared by Mr. Charles Colling, of Darlington, was exhibited through many parts of the country, and could have been sold for the enormous sum of two thousand pounds; and when slaughtered, after eight weeks' illness, the four quarters weighed upwards of a ton. But it is not alone at great ages that such weights have been attained. Repeated instances could be mentioned of short-horned heifers and oxen producing from one hundred to one hundred and fifty stones of beef, at from three to four years old. They are, indeed, frequently fattened and sold at the age of two years, at prices varying from eighteen to thirty pounds.

That this breed of cattle is not deficient in milking properties is sufficiently evident from their being preferred as milkers in some of the public dairies. They are found to afford a more steady supply throughout the season than some others distinguished for yielding large quantities, which last for a very limited time. The quality of the milk is often inferior to that of some of the other breeds; but instances are not wanting, in which milk of excellent quality has been produced by short-horn cows.

Upon a review of the valuable properties of this breed of cattle, it appears somewhat singular that it has not attracted more general attention. It is a prevalent opinion, that the climate of this country is too cold for the rearing of short-horns, and that food of the necessary quality could not be produced for them under ordinary farm-management. With regard to the first of these objections, it appears utterly without foundation, as there are many instances of their being reared to great perfection in this country, and they have found their way even to the Highlands of Scotland, where the climate is, by many degrees, colder than ours. The second objection is equally unfounded. There are few farms on which turnips cannot be raised, and these, with straw, will be sufficient for their winter food, the pastures supplying that of the summer.

The character of the short-horns varies somewhat according to the districts in which they are reared; and their milking and fattening properties have been developed in a greater or less degree, according to the caprice of the breeder. In some of the English counties, they are much better milkers than in others; but, in general, it may be said, that they are unrivalled in the combination of those qualities which render any variety of cattle valuable to the agriculturist—the production of a large quantity of milk, and a tendency to acquire flesh with facility.*

The middle-horns comprehend a great number of varieties, and are widely diffused. Many of them are much esteemed, and have been cultivated with attention, the introduction of foreign blood being guarded against with the most scrupulous exactness. They are more prevalent in the sister kingdoms than in this country, being considered as indigenous to them, and being accordingly found from one extremity of the island to the other. The varieties which have found their way into this country, are chiefly the Devonshire and the Ayrshire breeds, and they are those which are most deserving of attention.

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* "Disposition to fatten insures another valuable property, early maturity. This property is almost peculiar to the short horns. It is obvious that a disposition to fatten cannot develope itself, until the animal is allowed more food than will merely support life. Young cattle are frequently restricted to such quantity of food as will only support their growing constitution. This practice probably had its origin in that period of husbandry when the raising food for animals attracted little attention; and even after food became more plentiful, young cattle were restricted in its use, from a conviction erroneously acquired, that only cattle of mature age could be fattened. This prevalent practice confirmed a

The Devon forms a peculiar and beautiful variety, being well defined in its characters, and easily distinguished from every other breed. The skin is rather thin, and covered with curly hair; and the degree of curliness depends on the condition of the animal. Some of them, indeed, have smooth hair, it being in this case fine and glossy; but those with curled hair are preferred, as being considered more hardy, and being better feeders. The colour is a bright red, and any departure from this is considered an indication of a mixture of some other variety. The slightest intermixture of white is regarded with suspicion, even a spot on the forehead; and this is more particularly the case, if the colours run into each other by imperceptible gradations.

habit of treatment which was extended even to short horns, till a very few years ago. It was a prevalent custom for breeders of short horns, to keep them till four, and sometimes five years old, before they were fed off. Now that the breed is improved, and generally distributed, a more profitable system obtains. Three years is the longest period, and very frequently oxen are fed off at two years of age. I have frequently seen Mr. Robertson of Lady-kirk, have two and a half year old steers sold for £25 a piece, and brought to a weight of seventy-two stones each. The late Mr. Abraham Wilson, of Edington Mains, used to bring two year olds to eighty stones, and sold them at £28 a piece. At the great sales of stock, which took place at Phantassie, Mr. Rennie always realized £30 a piece for two year olds. These instances prove very satisfactorily, that two year old short horns can be made fit for the butcher; but of course, in accomplishing this object, proper management is requisite. To show what good management can accomplish, I may mention that I have seen breeders of short horns who farmed fine turnip land, but could never obtain more than £10 or £12 for two year olds, while their neighbours on inferior soil obtained £20 for cattle of the same age; and yet, in the former case, as much food had been consumed as in the latter."—*Quarterly Journal of Agriculture*, vol. vi. pp. 273–4.

The Devons are rather small in size; and, in this respect, the ox, the bull, and the cow differ much from each other. The first is decidedly larger than either of the others; the bull maintains a medium place, and the cow is by much the smallest. In the districts in which they are cultivated, the Devonshire cattle are valued highly for the purpose of labour, the oxen being quicker in their motions than those of any other variety, being little, if at all inferior, to horses in this respect. They have also a tendency to acquire flesh with facility, and are much prized on this account. As milkers, they rank far below many other breeds, at least so far as regards the quantity they yield; but it is of very superior quality—indeed, so much value has been attached to this property, that it has been regarded as compensating for the deficiency in quantity.

With regard to the comparative merits of the Devons, it appears that, when oxen are much employed for the purposes of labour, they are eminently deserving of attention, and are perhaps superior, in this respect, to almost any other breed in the kingdom; but when this is not an object in the rearing of cattle, it does not appear that their other good qualities are of such a nature as to make up for the great deficiency in the quantity of milk which they yield. The qualities of fattening readily, and yielding large quantities of milk, are rarely found in combination in any variety of cattle; but it is believed that they are to be found in greater perfection in some others than in the Devons.

An important and valuable breed of cattle belonging to the middle-horns is the Ayrshire. This breed, at least in its present improved state, is comparatively of modern origin. It derives its name from Ayrshire, and extends to the adjoining counties of Lanark, Dumfries, Renfrew, Dumbarton, and, more or less, throughout the different districts of the United Kingdom. Little more than half a century ago the cattle found in Ayrshire were a diminutive race, and possessing but few points of resemblance with that of the present improved breed. The improved Ayrshire, indeed, appears to be the produce of careful selection and good management; and when a breed having so many good qualities as this one undoubtedly possesses, is seen to be produced by such means, it holds out the greatest possible inducements for further exertions, which, if performed in the same judicious manner, will no doubt be crowned with similar successful results.

The animals of this variety are delicate in their horns and limbs, their foreheads are narrow, their shoulders thin, and their fore-quarters light. This is a form which is valued in the female as indicating a disposition to secrete milk, but it does not correspond with the form of an animal which indicates a disposition to grow to a great size and feed readily. Still, however, these qualities are combined in a much greater degree than an examination of the exterior conformation of the animal would suggest. But it is in an especial degree that this breed is suited for the dairy, and in this respect it is seldom rivalled.

Tameness and docility of temper are known to greatly enhance the value of a milch-cow. Some degree of hardiness, a sound constitution, and a moderate degree of life and spirits, are also qualities to be wished for, and what those of the Ayrshire generally possess. Other valuable qualities are the supplying of a large quantity of milk, and that also of a good quality; and that afterwards the animal shall possess a tendency to acquire flesh. These qualities the Ayrshire cattle have in a great degree. Were the sole object the production of flesh, the short-horns would be decidedly superior; but seeing that the production of milk is also important, the Ayrshire are eminently deserving of attention.

Being indigenous to a climate much colder than ours, and being also capable of subsisting on coarser food than most of the other improved varieties, this breed of cattle seems well adapted for the general circumstances of this country. The dairy forms an important part of the establishment of the Irish farmer, and for this purpose they are admirably suited. But they are also well adapted for fattening, though in this respect they are inferior to the short-horns.*

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* The shapes that are most approved of in the Ayrshire dairy are, according to Mr. Aiton, an enthusiastic admirer of that variety, the following: "*head* small, but rather long and narrow at the muzzle; the *eyes* small, but quick and lively; the *horns* small, clear, bended, and their roots at a considerable distance from each other; *neck* long, and slender, tapering towards the head, with little loose skin hanging below; *shoulders* thin; *forequarters* light and thin; *hind-quarters* large and capacious; *back* straight, broad behind, and the joints of the chine rather loose and open; *carcass* deep; *pelvis* capacious and wide over the hips, with fleshy buttocks; *tail* long and small; *legs* small and short with firm

Another esteemed variety of the middle-horns is the Hereford cattle, a race peculiar, in a great degree, to the county from which they derive their name. In several respects they resemble the Devons, and an affinity is, accordingly, sometimes attempted to be traced between them; but this affinity is by no means striking. The Herefords cannot be regarded as possessing their valuable qualities and well-defined characters from an early period, being, like all the other improved varieties, the effect of attention and assiduity on the part of the farmers of that county.

The Hereford oxen are considerably larger than the Devon. They are of a darker red, with white faces, and more or less of white on other parts. The hide is considerably thicker, and the animals in general more hardy. Compared with the Devons, they are shorter in the leg, and also in the carcass; higher, and broader, and heavier in the chine; rounder and wider across the hips, and better covered with fat; the thigh fuller and more muscular, and the shoulders larger and coarser. The females are small as compared to the size to which the oxen reach, a character likewise possessed by the Devons; and they partake, too, in the character of the Devons, and other allied breeds, in being bad milkers. The quality of their flesh is, however, good and much prized; and they are well suited for draught, although slower in their motions than the Devons.

Varieties of the middle-horns are to be found in almost every county in Britain, many of which are closely allied to each other in their characters, while others possess but few points of resemblance. Many of them have not found their way into this country, being little esteemed beyond their respective districts; but some have been long introduced, and are held in deserved estimation.

A variety of the middle-horns is usually considered indigenous to Ireland, a favourite specimen of which is the Kerry cow. These

joints; *udder* large, broad, and square, stretching forward, and neither fleshy, low hung, nor loose, with large and prominent milk veins; *teats* short, pointing outwards, and at a considerable distance from each other; the *skin* thin and loose; *hair* soft and woolly; the head, horns, and parts of least value small, and the general figure compact and well proportioned."

animals are found in mountains and unimproved districts. They are small, light, active, and wild. The head and neck are in general small. The horns are short, all of them fine, some of them rather upright, and frequently, after projecting forward, then turning backward. Although somewhat deficient in the hind-quarters, they are high-boned and wide over the hips, yet the bone generally is not heavy. The hair is coarse and long, and the colour is various; sometimes black.

These cattle are exceedingly hardy, subsisting frequently throughout the winter on their pastures, and sometimes living entirely in the open air, even during the most inclement season. Under existing circumstances they are well suited to many parts of the country, the tillage being so imperfect as not to afford the means of subsistence to the more improved breeds. They yield large quantities of milk compared with their size, and fatten in a short period when plentifully supplied with nutritious food. They cannot, however, be regarded as deserving of attention in the more improved districts, in which case they should give place to larger cattle.

The long horns now demand our attention. They existed from an early period in the district of Craven in Yorkshire, from which bulls were sent into all parts of the country. The Craven breed was originally distinguished by a disproportionate and frequently unseemly length of horn. In the old breed the horns often projected nearly horizontally on either side; but as the cattle became improved, they assumed other directions, giving the animal an extraordinary appearance, and sometimes even extended in such a manner as would seem to prevent the animal from grazing, or appearing to grow into some part of the jaw, were their extremities not removed by the saw. In the south and west of Ireland the long horns prevail, and on the luxuriant pastures of these districts they often attain to a large size.

These are the general characters of most of the long-horns to be found in this country, and were those also of the English long-horns, until the labours of Bakewell produced a change on many of the characters of the breed. The different breeds of cattle to be found in the United Kingdom have each been more or less improved by particular individuals; but of Bakewell it may be said that he created a new breed, which is still called by his place of residence in Leicestershire being termed the Dishley, and sometimes the new Leicester breed.

The long-horns formed the subject or basis of Bakewell's intended improvements; and by long perseverance and skilful selection he communicated to the breed the required properties of acquiring flesh with facility, and arriving early at maturity. Careful selection seems to have been the principle he adopted, always guarding that the parents should not each have a tendency to the same defect. Thus by careful selection in the first instance, and constant care afterwards, without any regard to the consanguinity of the parents, he at length produced a variety of the long-horns, which, for arriving early at maturity, and a disposition to fatten, were unrivalled. But not being aware that long-continued breeding from too close affinities tends to make the progeny, during each succeeding generation, less hardy than their parents, he appears to have carried the system of breeding in-and-in to too great an extent, and some of his cattle showed palpable signs of degeneracy in his own day. Experience still further showed that they had lost their original hardiness of constitution, and the progress of degeneracy was only arrested by crossing with some of the other breeds.

The long-horns have been losing ground in England, although the exertions of Bakewell enabled them to contend, and sometimes successfully, with the heaviest and best of the middle-horns. The short-horns, however, have gradually displaced them, and there is not a vestige at present of the new Leicester or Dishley breed of long-horns to be found where they had their origin.

The long-horns continue to maintain their ground in several grazing districts in Ireland, and are much prized. They are good milkers, although they do not excel the short-horns or the Ayrshires in this respect. They grow to a good size, but they do not seem to acquire flesh with facility at an early age. Their large size necessarily confines them to the more improved districts, but in these the short-horns would be found much more profitable.

The polled or hornless breeds of cattle are not numerous, and are rarely met with in this country, there being no distinct breed of polled cattle in it, those occasionally seen belonging to some of the horned breeds. In the south-west of Scotland, however, a distinct breed of polled cattle exists. In size and characters they are a mountain race, and little suited for improved and favourable situations. They are indifferent milkers, though their milk is of good quality. They are hardy, docile, and good feeders, and perhaps, well suited to the situation in which they are reared. The prevailing colour is black. The breed takes its name from the district in which it is found, being usually termed the Galloway breed.

In selecting from the varieties of cattle which have been enumerated, the farmer must be guided by the peculiar circumstances of his particular case. The breed must be adapted to the means, natural or acquired, possessed of supplying food. Art and an improved system of tillage can do much in supplying the food of herbivorous animals. By cultivation we can change the nature, and increase the quantity of the food supplied. But in many cases tillage is only practicable or expedient to a limited extent, and then the natural pastures of the country must furnish the main supplies of food. In mountainous districts, where the principal food is natural herbage, and where the means do not exist of obtaining artificial food, it would be vain to attempt the rearing of a large and fine breed of cattle. We must, in such a case, be satisfied to rear a race possessing hardy properties, of a small size, and capable of subsisting on coarse herbage. When, again, art or the natural fertility of a district admits of supplying sufficient food, the study of the breeder should be to select a race of animals, the best that circumstances will allow him to rear.*

In all the improved lowland districts of Ireland, the short horned cattle will undoubtedly afford a much larger return than any other. In such situations the climate will be found perfectly suited to the constitution of the animals ; and such as are not intended for the dairy may be sold fat at three years old, when they will yield as large a return as the long-horns at five years, the age at which they are commonly fattened in this country.

In the more exposed situations, the Ayrshire cattle are to be preferred, as being more hardy, and capable of subsisting on coarser food. It has been seen that they are suited in an especial degree for the dairy, and that they have also a disposition to fatten in as great perfection as most of our other breeds. When the Ayrshire stock of cattle is kept for the dairy, it will be found a good arrangement to breed from a short-horned bull, and the produce of this cross will have a disposition to fatten in a greater degree than the cow, while it will be more hardy than the bull. The animals reared in this way are, of course, intended for the shambles as soon as they shall have become sufficiently fat, as it is seldom advisable to breed from crosses, unless when an improvement is contemplated, by engrafting some peculiar quality on a stock already possessing many good properties. In this case such animals as are intended for keeping up the stock of cows will, of course, be the produce of an Ayrshire bull instead of a short-horn.

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* Elements of Practical Agriculture.

In the still more elevated and mountainous situations a still hardier race must be selected. It may consist of some of the native breeds, possessing as many good qualities as appear compatible with the intended situation. An improved variety for such situations would be produced by a cross between a short-horn bull and a cow of the native stock. This cross should not, perhaps, be repeated beyond a single time, until its effects would be perceived. In the first instance, more of the sire might be apparent in the progeny than could be wished, or appears adapted to the intended situation ; but this will be always becoming less apparent, and may be preserved at any degree the breeder may think advisable. Crossing is, in this case, often attended by the best results, and is calculated to effect a beneficial improvement in a short space of time. It is only when carried too far that it is found to be injurious.

II.—ANATOMY AND PHYSIOLOGY OF CATTLE.

The general structure of cattle presents some peculiarities when compared with the horse, whose anatomy, having been already treated of, will be taken as the subject of comparison. The ox, as an animal machine, displays less complexity of structure than the horse; but the principal differences between the two will be found to arise from the evident intention of nature to bound the locomotion of horned cattle. The limbs of the ox are, therefore, not found favourable to speed, nor does his general mass display that symmetrical proportion and mechanical composition that would fit it to be acted on to advantage, as regards quick motion, by the powerful muscles he evidently possesses ; for strength alone will not produce speed.

A striking point of difference between the conformation of the head of the horse and that of the ox consists in the great enlargement of the frontal bones in the latter, which becomes necessary for supporting the horns. The forehead thus becomes broad and short, and the peculiar conformation of this part is a matter of some importance. This shortness and breadth of forehead is not only characteristic of difference of sex, but it is regarded, and properly, as an essential point in a bull. A deficiency here argues want of constitutional vigour, and materially interferes with the usefulness of the animal. But, on the other hand, a cow with a large head and broad forehead is usually deficient in the most valuable qualities of the feminine character, being invariably a bad milker, and seldom having a disposition to fatten. When this enlargement of the breadth of the forehead, even in the male, goes beyond a certain extent, it denotes a ferocious disposition ; and animals of this description should be carefully watched, as they may unexpectedly display this fearful propensity, and do much mischief.

The horns are merely a prolongation of the frontal bones, evidently intended for the protection of the animal. They begin to appear in the fœtus of about four months old, when they are only detected by a little irregularity of the frontal bones. This continues to increase, and, by the end of the seventh month, it is apparent to the eye. The horn has generally forced its way througn the cutis, or true skin, by the time of parturition, and, continuing to grow it detaches the cuticle from the cutis, and carries it with it; and this, gradually hardening over it, forms the rudiment of the future horn. Beneath this cuticle the horn soon begins to form, and continues covered until the animal is twelve or fifteen months old, giving to it a skinny roughness, which then peels off, showing the shining and perfect horn.

As the animal advances in age, rings appear round the horn, indicating its first growth from its base, and these are often considered as a criterion of age. At three years old, the first distinct one is usually observed; at four, two are seen; and so on, one being added each succeeding year. Thence has been deduced the rule, that if two were added to the number of rings, the age of the animal would be found. These rings, however, are perfectly distinct in the cow only; for, in the ox, they do not appear until he is five years of age, and they are often confused; and in the bull they are still less to be depended on. They are not, indeed, in any case, to be relied on; and are easily removed at the option of the dealer.

In the ox, the nippers are wanting in the upper jaw; and, instead of them, the bars thicken towards that part of the mouth, and there they accumulate into a pad, which covers the convex extremity of the anterior maxillary bone. This is the case in all the ruminants, or such as chew the cud. The effect of this structure is, that, instead of being cut through, the grass, in browsing, is partially cut and torn up also by the roots, as may be observed by the motion of the head of the animal. With the roots of the grass, a portion of earth is necessarily taken into the stomach, which there acts as an antacid, and facilitates the process of digestion.

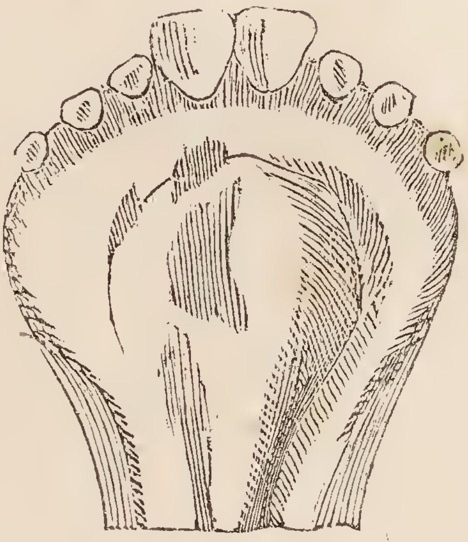
The mouth of the ox, when full, contains thirty-two teeth, eight incisors in the lower jaw, and three molars in each jaw above, below, and on either side. The incisor teeth are admirably adapted to perform their function. There being no corresponding ones opposed, but merely an elastic pad, they must possess an edge of considerable sharpness, in order to perform this half-cutting, half-tearing process. The elasticity of the pad preserves it from laceration when coming into contact with these sharp edges.

As in the horse, the teeth present certain characters, by which the age of the animal is ascertained. Unlike the horse's the appearance of the teeth will seldom deceive the experienced dealer, and, therefore, is of importance, as forming a criterion of age.

The mouth of the calf after birth presents an uncertain appearance, depending on the usual period of gestation having been completed or not. Sometimes there will be no vestige of teeth; but, generally, either two central incisors will be protruding through the gums, or they will have arisen, and attained considerable bulk. Two additional incisors will appear in each of the two succeeding weeks; and, at a month old, the full number of incisors will have appeared.

These are the temporary, or milk teeth, and they serve every useful purpose for which they could be required for some time. But, as the bone of the jaw becomes enlarged, they cease to fill up the space over which they extend, and are also diminished in size by continued use. The size of the teeth continues to decrease, and the spaces between them to increase, until about the expiration of the second year, when the central ones are displaced, and in their stead two permanent teeth appear. The annexed figure represents the state of the teeth at this period. The two permanent central incisors are coming up, and the other six milk teeth remain.

Fig. 84.



After this period, two additional teeth are displaced every year, and their place occupied by two permanent teeth, until the commencement of the fifth year, when the eight permanent incisors will be up. The corner ones will, however, be small compared with the others; but they rapidly increase in size, and by the commencement of the sixth year, or some time before, they will have attained their full size. At this period the animal is said to be full-mouthed.

The other parts of the head of the ox present few characters of importance different from those of the horse, and need not, therefore, be described.

The neck of the ox is composed of seven bones, possessing the same relative situations, and distinguished by the same names, as those of the horse; but, from the diminished elevation of the head, and the peculiarity of the attachment of the great suspensory ligament, the ox has no cervical crest. In the female there is no perceptible elevation; but it is regarded as an indispensable point in the bull, that there should be a rising crest in a slight degree. The form of the neck is strangely modified, according to the sex of the animal; but, in general, it should be small at the joining of the head, and increase in size towards the chest. Smallness of neck throughout its whole extent is usually attended by a general lightness of carcass, which will materially affect the value of the animal.

In the ox, the form of the chest is very different from that of the horse, the animal being intended for different purposes. Breadth at the breast is an essential requisite, as this form only is that which will give sufficient surface for the attachment of muscles of the character of those of that animal, and will secure sufficient room for the lungs to purify, and the heart to circulate, blood enough for the proper discharge of every function. There is also a singular projection of the front of the chest seen in this animal, called the *brisket,* to which much importance has been attached. In all the improved breeds the projection is considerable, and being composed chiefly of fatty matter, it is considered as a proof of a tendency to fatness.

In the spine of the ox, the joints are larger and fewer in number than in the horse. The spinous processes of the anterior bones of the back, constituting the withers, are stronger, but not so long. While a very slight curve should mark the situation of the withers, the irregularity of the processes of the bones should never be visible. The less the curve the better; and no decided hollow behind should point out the place where the withers terminate, and the more level surface of the back commences. This is a departure from good conformation, for which nothing can compensate. It not only takes away so much substance from the spot on which good flesh and fat should be thickly laid on, but it generally shows an indisposition to accumulate flesh and fat in the right places.

The viscera of the belly have some specialities, the principal of which consists in the digestive organs, which differ in the form, structure, and economy, in some essential particulars, from the same system in the horse.

The ox has four stomachs; in which formation, the sheep, goat, deer, and camel, participate. As it is necessary that these animals should collect much herbage for their support, and as it would fatigue and keep them too long in motion to gather and masticate such a quantity at the same time, so a peculiar provision has been made for them, by which they first hastily collect their food, pass it into a reservoir, and afterwards commence the mastication of it at their leisure.

To accomplish this purpose it is evident that the food must again be returned from the stomach to the mouth by the œsophagus, or gullet, and to enable this organ to perform its function, it must possess a somewhat peculiar construction. As compared with that of the horse, it is much larger in size. The outer coat of loose cellular substance is the same in both—yielding and elastic. The second coat is a muscular one, and of great substance and power. Its increased substance enables it to dilate when large pieces of food enter it; and the same increase of muscular substance enables it to contract more powerfully on such food, and pass it on to the stomach. There are two layers of muscle in the gullet of all our domestic animals, but the fibres of the outer and inner layer run in different directions, according to the food and habits of the animal. In the horse the one is circular or transverse, and the other longitudinal. In the ox the fibres of both layers of the muscular coat are spiral, but they wind their way round the gullet in different directions, thus admitting of the lengthening and shortening of the tube in grazing and swallowing; offering, perhaps, not so much pressure on the food, which the slow mastication and rumination of the animal do not seem to require; but permitting a great deal more dilatation when some large and hard substance finds its way into the gullet.

After entering the chest the gullet increases rapidly in size, and becomes funnel-shaped at its lower end. It enters the *rumen*, or paunch, which is a very large, membranous, and muscular bag, principally occupying the left side, and extending, when full, from the middle of the ribs to the haunch. All the food, when first swallowed, enters it, there to be preserved for the act of rumination; and a portion, and occasionally the greater portion, of the fluids that pass down the gullet enters the rumen.

Farther on is the *reticulum*, or second stomach. This would appear as a globular appendage to the paunch merely, were it not for its peculiarity of structure, which resembles the cells of the honeycomb, and is well known as an article of food. The gullet enters at the junction of this with the rumen, and is continued in the form of a muscular ridge along the line of junction between these two stomachs, being thence continued to the third stomach. The reticulum is a little curved upon itself, and is the smallest of all the stomachs. It rests against the diaphragm in front of the left part of the rumen, and is placed upon the abdominal prolongation of the sternum.

The third stomach is named, after its foliated structure, *many-plies*. There are about eighty or ninety of these septa or folds, which are covered with cuticle, in common with the two former stomachs, by which some resemblance is kept up between the digestive processes in the horse and in ruminants. It is less rounded and longer than the reticulum. By the curious extension of surface which the manyplies possesses, the ruminated food is applied and reapplied to the sides of the bag, to be acted upon in its early stage of digestion.

The *abomasum*, or fourth stomach, is elongated and of a cone-like form, situated obliquely, and to the right of and behind the manyplies, and between the diaphragm and the right sac of the rumen. It is lined by a soft villous membrane, like the digestive portion of the stomach of the horse. It also contains a great number of folds or leaves, somewhat irregularly placed, but running chiefly longitudinally. They are largest and most numerous at the upper and wider part of the stomach; and one of the folds, in particular, is placed at the entrance into the abomasum, yielding to the substances which pass from the third stomach into the fourth, and leaving, as it were, a free and open way, but opposing an almost perfect valvular obstruction to their return. This coat of the stomach, when the animal is in health, is thickly covered with mucus, while, from innumerable glands, it secretes the gastric juice or true digestive fluid.

Rumination, or chewing the cud, is the process whereby the ruminant animals, having collected their food, and having passed it into the rumen with little or no mastication or admixture of saliva, return it again to the mouth to be further prepared for the process of digestion. The rumen being full, the animal is usually disposed to seek rest and quiet, and generally lies down. The only change that takes place in the food in a healthy state and action of this stomach is that of maceration and preparation for the second mastication, as may be ascertained by taking from the mouth of a cow a portion of the food returned for mastication a second time. This will be found to differ from the original food only in being macerated, and in containing a small portion of mucus.

The maceration of the food is performed through the instrumentality of the muscular action of the rumen, and, after the process has been continued for a certain length of time, it is forced into the reticulum. From this it is returned to the mouth to be there submitted to a second mastication, generally very leisurely performed, and continued until enough is ground not only to satisfy the cravings of hunger, but to fill the comparatively small true stomach and intestines of the animal. After being duly masticated and mixed with an additional portion of saliva, it is again swallowed ; but, instead of entering the first stomach, it is carried on to the third. Here an admirable provision is found for the perfect comminution of the food. That which is quite ground down is permitted to pass on ; but by the peculiar structure of the many-plies every particle of fibre that remains is further reduced, and not suffered to escape until it becomes a pulpy mass.

These three stomachs, then, are evidently designed for the preparation and comminution of the food before its enters the fourth stomach, in which the process of digestion may be said to commence, and where the food, already softened, is converted into chyme. The villous coat of the abomasum secretes the gastric juice, through the agency of which chyme is produced. This substance passes through the lower orifice of the stomach into the duodenum or first intestine, where its separation into the nutritive and innutritive portions is effected, and the former begins to be taken up and carried into the system.

The liver of the ox is large, and presents a *gall-bladder*, which that of the horse does not. By the existence of the gall-bladder the bile is more concentrated. and is retained there while the animal is feeding, and at such times as the process of digestion is not going on, and served out in such a quantity as is required.

The extremities of the ox are somewhat different from those of the horse. The knee is composed of four bones in the first row, and two in the second, which renders that joint inferior to that of the horse in complexity and elasticity. The same holds good with regard to the hock. The cannon or shank has no splint-bones attached to it, but it is lower, and enlarges into two articular portions. From the pastern downwards the limb is double, and ends in two separate hoofs, which present individually a similarity of structure and design to the single hoof of the horse, but less perfectly developed. To the posterior part of each are appended two imperfect phalanges, or claws, thus maintaining a connexion with the digiti.

III.—DISEASES OF CATTLE.

Cattle are subject to numerous and often dangerous diseases; but as their life is less artificial, and their structure less complex, than in the case of the horse, so they are not liable to the variety of ailments which affect that animal. The pathology of cattle has been much less attended to than that of the horse, not that this species of stock is less valuable, but from the circumstance that the animals can be used as human food at almost any period; and in case of accidents or diseases they are usually disposed of in this manner. The treatment of the diseases of cattle has hitherto been confined to more ignorant practitioners than even those of the horse, and the most absurd methods of cure have been recommended, which are not only useless but often injurious. Many of the diseases of cattle resemble those of the horse, and require similar treatment; they shall, therefore, be briefly treated of in this place.

Cattle are subject to numerous febrile and inflammatory affections, some of which are of an alarming character, and annually carry off numbers of the farmer's stock. Having entered into the causes and treatment of similar affections of the horse, the farmer, after carefully attending to what has been then stated, will seldom be at a loss how to act in those cases when they occur among his cattle.

Fever has been said to consist in increased capillary and arterial action, either with or without any local affection; or it is the consequence of the sympathy of the system with inflammation of some particular part. The first is called pure or idiopathic fever, and the latter symptomatic fever. To the former the term mild fever is frequently applied.

Pure Fever. This affection frequently occurs in cattle, but it is seldom fatal in its termination. The symptoms are general heat, redness of the nostrils and eyelids, and dulness and carelessness of action. Rumination has generally ceased, the flanks are seen to heave a little, the root of the horn becomes unnaturally hot, and the pulse is quickened, and somewhat hard. The symptoms are usually intermittent, being sometimes scarcely perceptible, at others violent, and continuing thus for several days. But they frequently remain without these intermissions, and continue to increase. Some organ previously disposed to disease becomes affected, and then symptomatic fever appears. This is a serious and frequently a fatal case; for the whole system having been previously affected, and probably debilitated and disposed to take on an inflammatory action, the proper remedies cannot be so fearlessly and successfully used.

From the nature and symptoms of this affection, the treatment is sufficiently evident. Bleeding, cordial purgatives, and cooling diet, are to be employed.

Inflammatory Fever. Cattle are not subject merely to fever of common intensity, but many of them fall victims to a disease which, from its virulent character and speedy course, may be termed inflammatory fever. It is known by various names, being sometimes termed *black-quarter*, *quarter-evil*, and sometimes, though inappropriately, *black-leg*.

Inflammatory fever is chiefly confined to young cattle, but it is not by any means peculiar to them. It appears generally in the spring or the autumn. On poor soils and exposed situations, it is almost unknown. It has been sometimes attributed to the presence of certain acrid plants in the pastures where the animals have been feeding, but these cannot have any effect in its production, it being clearly the effect of too high feeding, and the consequent excess of healthy stimulus. This disease is the penalty which the breeder must pay, or the evil which he must carefully, and not always successfully, endeavour to avoid, when he is trying to obtain all the advantage he can from the richness of his pastures, and the aptitude to fatten and early maturity of his cattle.

This disease is sudden in its attack, and unless treated promptly, is generally fatal in its termination. Without any indications of previous illness, the patient will have difficult breathing, disordered pulse, and every indication of intense pain. This will speedily be followed by tenderness on the loins and back, with swelling, which, when pressed by the hand, yields with a crackling noise. Decomposition has, in this case, taken place, and the disease will, in a short time, prove fatal.

As in the case of the inflammatory diseases of the horse already treated of, the most prompt and decisive measures must be taken with a view of subduing the inflammation. The first and most important step for this purpose is copious depletion. As much blood should be taken as the animal can bear to lose; and the stream must flow on till he staggers or appears to fall. The quantity of blood in this case is no criterion to judge by, and the operator will fearlessly continue to abstract blood until faintness is produced. After the abstraction of blood, an endeavour must be made to restore the proper action of the bowels, constipation being a usual concomitant of the disease. A pound and a half of Epsom salts should first be administered, and should this not take effect, the dose is to be repeated in smaller quantities at intervals of six hours, until the intended effect is produced.

The first favourable symptom is the pulse becoming slower; and when this has taken place, and the purgatives produced the desired effect, sedative medicines are to be administered. A drachm and a half of digitalis, a drachm of emetic tartar, and half an ounce of nitre should be given three times every day. A seton may be inserted in the dewlap; and those of black hellebore root are the best, as producing the quickest and most extensive inflammation.

This treatment will usually be successful in the early stages of the disease; but if it be farther advanced, the most vigorous measures will be necessary. The bleeding and purgatives are to be employed; and with the latter stimulants must be administered, to excite the rumen to action, if the drink should get into it, and also to stimulate the fourth stomach and the whole frame, if, fortunately, it should reach so far as this stomach. Even when decomposition has commenced in the part more immediately affected, a cure may be tried, but the hopes of a successful termination must then be very slight. In this case bleeding is not to be resorted to, as the vitality of the system has already received a sufficient shock; but physic is necessary, with a double dose of the aromatic, to rouse the energies of the digestive system, and to get rid of much offensive and dangerous matter collected in the intestinal canal. Should eruptions have appeared in the diseased part, they are to be washed with a solution of chloride of lime. Mashes and plenty of thick gruel should be given, and forced, by means of the stomach-pump, if the animal refuse to take them voluntarily.

Inflammation of the Brain, Lungs, &c. Cattle are occasionally subject to these diseases, but much seldomer than the horse. The treatment of the several cases of inflammation, and also of tetanus, apoplexy, and other affections, when they occur in cattle, is little different from that prescribed in the case of the horse.

Catarrh or Hoose. Colds are frequent amongst cattle, and often prove a source of serious annoyance. It is often hard to say whence catarrh, or common cold, arises. In general, however, it is the result of mismanagement, being brought on by the too sudden alternations of temperature, produced by our artificial system of treatment. When cattle are confined in close houses, the atmosphere becomes heated, often to many degrees above the external air, and cold is a certain consequence of this treatment. But cold is also produced from undue exposure, without any defective management in this respect.

There is no disease of a chronic nature by which cattle are so seriously injured, or is eventually so fatal to them, as catarrh ; yet it is seldom attended to, from a notion that it will soon disappear without any remedial measures being used. In the early stage, indeed, it is comparatively unimportant, but, if allowed to remain on, it may be followed by fatal consequences. The remedy consists in bleeding, and administering physic, which may be Epsom salts ; and half an ounce of ginger should be added to prevent griping, excite perspiration, and stimulate the rumen to action.

Occasionally catarrh assumes an epidemic form, spreading over whole districts, and being more than usually virulent. The treatment now becomes difficult and uncertain, owing to a diversity of symptoms, arising often from the presence of another disease in connexion with catarrh. Decisive measures must be used ; and the first and most important remedy is bleeding. A high state of inflammatory action being now present, the quantity of blood to be drawn will depend on the extent of that action, by the apparent approach or commencement of debility, and by the effect produced while the blood continues to flow. Aperients will afterwards be administered, accompanied or not by aromatics, according to the preponderance of fever or debility. While fever continues, sedative medicines are to be given, and, after the febrile stage is over, tonics.

Murrain or Malignant Epidemic. This disease is sometimes the result of epidemic catarrh, which has a tendency, in a greater degree in cattle than in the horse, to assume a malignant form, on account of the greater vascularity of the system, and intensity of febrile action. Murrain also appears as malignant from its very commencement.

From the earliest period of which we have any authentic records, it has been the pest of cattle, and often swept away the stock of entire districts. It is strangely whimsical in its appearance; in districts in which it has been hitherto unknown, it sometimes appears with the greatest virulence. It is, however, chiefly confined to marshy countries, and districts in which draining is imperfectly performed.

The early stage of murrain is evidently one of fever, and the treatment must be determined accordingly. Bleeding should, therefore, take place, and it need not be confined to the early stages alone, but may be afterwards performed, the quantity to be regulated by the particular state of the animal. Purgatives should next be cautiously administered, as there is often a great degree of looseness of the bowels attending the disease, but still moderate doses may be given, for the physic will carry away much of the offensive matter from the intestinal canal. Sedative medicines should rarely be used, unless the cough continues; but an increased quantity of aromatics will be attended with good effect. Should diarrhœa appear to any extent, sedatives, mingled with vegetable tonics, should be administered, and along with them mild astringent medicine may be given. Chloride of lime is to be applied to the external eruptions; and it should not be confined to the ulcerated parts, but plentifully sprinkled over the animal. A little of the chloride may also be administered internally, with the other medicines, with a view to lessen the tendency to general decomposition, which is so fearfully apparent.

The treatment of this disease is most unsatisfactory. It is fortunate that it is of such rare occurrence, and, when it does appear, that it is, in a great degree, disarmed of the virulence by which it was formerly characterized. As a preventative measure, the appearance of coughs among the cattle should be looked on with suspicion, and met with active and proper remedies. From ordinary or even increased and long-continued coughs, murrain is seldom anticipated, but it may appear, and even in this case, bleeding and physicking when the cough first appeared, will have disarmed it of much of its virulence. Being usually regarded as highly epidemic, the infected animal should be immediately removed from the others, and the chloride of lime should be liberally used about the animal, and sprinkled over the stall, it being a powerful agent in neutralizing infection, and restoring substances already tending to putridity, to soundness.

Inflammation of the Liver. This disease occurs much more frequently in cattle than in the horse, and those that are stall-fed are especially subject to it. The symptoms of inflammation of the liver are exceedingly obscure, and not to be depended on. An almost invariable one, however, is yellowness of the eyes and skin; but this accompanies, or is the chief characteristic of obstruction of the biliary duct, and possibly exists without the slightest inflammation of the substance of the liver. It should also be remembered, that there is scarcely any acute disease to which cattle are subject in which the liver does not sympathize. In addition to the common symptoms of fever, those that would lead to the suspicion of inflammation of the liver would be, lying continually on the right side, slight spasms on that side, and considerable pain on pressure being applied to it. There is usually some degree of constipation; the urine is yellow or brown, or, in some few cases, bloody, and voided only in small quantities.

The proper remedies are bleeding, physic, blisters on the right side, and restricted diet, from which every thing of a stimulating quality is withdrawn.

Jaundice or Yellows. This disease also occurs frequently among cattle, and is characterized by a yellow colour of the eyes, of the skin generally, and of the urine. Its appearance is sometimes sudden, at other times the yellow tint gradually appears and deepens. In some cases, it seems to be attended for some time by little pain or inconvenience, or loss of condition; in others, its commencement is announced by an evident state of general irritation and fever, and, particularly, by quickness and hardness of pulse, heaving of the flanks, excessive thirst, and the suspension of rumination. The usual cause of the disease is obstruction of the passage of the bile from the gall-bladder into the duodenum, caused by biliary secretions, or calculi in the duct. Being impeded in its natural course, it is quickly diffused through the frame, and the consequent yellow appearance is produced.

This obstruction is eventually followed by violent spasmodic action from the irritation it produces. To allay this, bleeding should be resorted to, which should be continued until the animal becomes faint; and, during this partial sympathy, the muscles of the duct may cease their spasmodic constriction, and the calculus may pass on. To this should be added powerful purgation, consisting of doses of a pound and a half each of Epsom salts, or a pound of the salts with ten grains of croton, the medicine being repeated once in six hours, until purging is produced. Mashes should be given to hasten and increase the action of the physic, and opium, or digitalis, and particularly the latter, may be given in doses of half a drachm, with a view to allay the violent constriction of the duct.

Obstruction in the Gullet. This sometimes occurs both in horses and cattle, and is far more fatal in the former case than in the latter, although not so frequent. It occurs chiefly when young cattle are first supplied with roots, when the mastication is often careless and imperfect. It has also been remarked, that some animals are more disposed to this accident than others, and that when it has once occurred it is extremely liable to occur again in the same animal, either from a voracious habit of feeding, or from weakness in the gullet itself.

When cattle are first put to feed on roots, and, indeed, at all times, they should be attentively watched, and the first symptoms of obstruction or choking immediately noticed. This is the more important, as the obstruction is more easily removed soon after the attempt to swallow it, than when it has remained some time, and caused considerable irritation in the gullet, by the repeated efforts of the animal to force it down. At this period, it is probable that it may be returned with less difficulty than forced onwards. The internal coat of the œsophagus is naturally smooth and glistening, but it may be made more so, and the surface of the obstructing body polished too. Half a pint of olive oil should be poured down the throat, and an attempt then made with the fingers, applied externally, to give the body a retrograde motion. By patient and careful manipulation, this will be effected much oftener than is imagined. The intruding substance will be dislodged from the situation in which it was impacted, and will be brought into the upper part of the œsophagus, or even into the pharynx, and will then sometimes be got rid of by the efforts of the animal, or may easily be drawn out by means of a hand introduced through a large mouth-piece, put into the mouth for protection.

But should this mode of operating prove unsuccessful, an endeavour must be made to force the obstruction into the stomach, by means of the œsophagus tube, or *probang*. This is an elastic tube, made either simply of leather, or of leather covering a canal formed of spiral wire. It is about four feet and a half in length, so as to reach from the mouth to the rumen, and leaving a sufficient portion outside the mouth for it to be firmly grasped. The elasticity of the tube enables it to accommodate itself to the winding of the gullet, and when it is wished to lessen this elasticity, a stillet is introduced into it, running through its whole length, and having a handle to guard against its projecting beyond the probang, and to enable the operator to remove it at pleasure. This instrument is now procured without difficulty at every saddler's, and should be in the possession of every farmer.

The end of the probang is to be introduced, and a moderate degree of force used to propel the obstructing body forward. If it yields to this, the operator will be justified in pushing it on with the chest; but if, with the application of a fair degree of force, it is very slowly and with difficulty pushed on, the operator should relinquish the determination to drive it down; for the fibres of the muscular coat of the gullet soon become irritated by the continued distention, and contract powerfully, and, as it were, spasmodically, upon the foreign body, and imprison it there.

Both these attempts having failed, another plan is to be tried. An important improvement has been added to the elastic tube in the form of a screw appended to the end of the stillet, by which an additional chance of removing the obstruction has been placed within our reach. When this instrument is used the stillet is pulled up, so that the screw is perfectly retracted. The tube being pressed down until it comes in contact with the obstructing body, by means of the handle of the stillet the screw is worked into it, as the common corkscrew is into a cork in the neck of a bottle. If the potato or turnip is fresh and sound, which, in all probability, is the case, or it would not have resisted the efforts already made, a considerable purchase will be obtained, and, in many instances, it will be at once drawn up by the screw. If the centre of the root should give way, and a portion of it only be brought out, there is still some good done; and the screw should be returned again and again, until it will no longer take hold. In this manner the root will be so much reduced as readily to give way to the probang.

When the means just described are properly employed they will, in almost every case, effect the removal of any obstruction which may have found its way into the gullet. There may, however, be particular cases in which all may fail, and then there is a last resource, and one which can seldom be safely ventured on without the assistance of an experienced practitioner. This is cutting an opening into the gullet, and thereby removing the obstruction, and afterwards sewing up the wound. As a last resource it may be attempted without reluctance, there being still a probability that the animal may afterwards do well, but without the removal of the source of annoyance death will undoubtedly soon ensue.

These directions have been founded on the supposition that the foreign body is lodged in the gullet above the entrance into the thorax, for, in the event of this not being the case, the chances of saving the life of the animal are materially diminished. The probang should first be tried, and that failing, the screw should be resorted to, either to draw the body out, or so to pierce and break it down, that it may be forced onward. The practitioner must stand at little ceremony here, and he should, if necessary, use all the force he can; for, if the obstruction is not overcome, the animal will assuredly perish.

Distention of the Rumen from Food. When describing the digestive apparatus of cattle, the rumen was seen to be a depository for storing the imperfectly-masticated food, until, by the process of rumination, it should be more thoroughly comminuted and fitted for the action of the gastric juice in the abomasum. But when the animal is put into a luxuriant pasture, or otherwise supplied with an unlimited quantity of food after fasting for some time, an undue portion is sometimes stored up, and distention and consequent excruciating pain in the rumen are the result.

This distention of the rumen frequently occurs among cattle, and as the symptoms closely resemble those of distention from quite another cause, much caution must be used in the treatment of it. The stomach is sometimes distended by the fermentation of its contents, and the consequent quantity of gas evolved; but distention from too much food may be distinguished from this by passing the probang into the rumen, and, when it is distended with gas, a sudden and violent rush of the imprisoned air will follow. They may also be distinguished from each other by ascertaining the nature of the food to which the animal had access for some time previous, and the probable quantity of that food consumed ; but it is always proper to use the probang, not only to determine this point, but to ascertain the degree to which the rumen is distended by the excess of food consumed.

When the distention has only taken place to a limited extent, and does not threaten a fatal termination, bleeding and active physicking will generally be sufficient, and the distention soon be allayed. Stimulants will also be found useful as exciting the stomach to action, and they may be administered with the purgatives. When these have taken effect, and the process of rumination again resumed, no fears need be entertained regarding a favourable result.

When, however, the symptoms indicate the presence of the most intense distention, such as continual shifting of posture, moaning, swelling at the sides, the flank feeling hard and not yielding to pressure, the case is serious, and admits of no delay. Rumination is suspended, and the other symptoms continue to increase. In this case mechanical relief must be afforded.

Should the probang enter a little way into the stomach, and the operator be able to move it about, he will have proof that, although the paunch is sufficiently distended to produce severe annoyance and considerable danger to the animal, it is not stretched to the utmost ; and he will consider whether he may not first try the effect of mild measures, which he will be especially encouraged to attempt if he finds that the food is of a rather light nature. But if the probang cannot be introduced at all into the rumen, or the food eaten be heavy, an incision should be made into the rumen through the left flank, and thus extract the contents. This mode of proceeding, however, is recommended only in cases of extreme distention with heavy food. The rumen of cattle, having few blood-vessels and nerves, will endure very severe treatment without considerable injury. The principal danger is, that a portion of the food will, during its extrication from the stomach, fall into the abdomen, and there remain a source of irritation, and often the unsuspected cause of serious and fatal disease.

Distention of the Rumen from Gas. This, it has been seen, differs from distention from food, and requires very different treatment. The rumen is, however, generally filled with food to satiety even in this case, and this causes the cessation of its natural powers, which would otherwise retard fermentation. But in the absence of these powers, and exposed to the combined influence of heat and moisture, succulent vegetable food has always a tendency to ferment, and here the commencement of the fermentation is hastened, and the effect increased. This is frequently called by farmers *hoove* or *blown*, terms sufficiently indicating its nature.

In the healthy discharge of the functions of the stomach, the food simply undergoes a process of maceration or softening; but if the food be retained in the stomach longer than the usual period, it, or perhaps only a portion of the juices which it contains, begins to ferment; or, as in animals with simple stomachs, even this preparatory one may so sympathize with certain states of the constitution, as either to secrete an acid principle, or to favour the development of it in the food. It is from this cause that some degree of hoove accompanies most fevers; it is often the consequence of general irritation, produced by obstruction of the œsophagus; and it sometimes accompanies difficult parturition.

The symptoms of hoove cannot be mistaken. Swelling, unwillingness to move, and laborious breathing, are the first and distinguishing symptoms. In proportion as the stomach becomes distended by the extricated gas, the case becomes more desperate, not only from the pressure on the other contents of the abdomen, thus impeding the circulation of the blood, and also on the diaphragm, against which the rumen abuts, and thus impeding respiration, and also the danger of rupture of the paunch; but the construction of the gullet renders it manifest that the rumen will be more obstinately closed in proportion as it is distended. The animal cannot long sustain this derangement of important parts; inflammation is set up, and the circulation becomes seriously and dangerously disturbed by this partial obstruction. Unless immediate relief be obtained, extinction of the vital powers will speedily ensue.

The treatment evidently consists in effecting the liberation of this gas, which is the cause of the distention, and the prevention of any more being formed. This would seem to be effected by the use of an active purgative, which would open a passage through the bowels, and get rid of much of the source of annoyance. The action of purgatives in cattle, however, can seldom be depended on when an immediate effect is to be produced, from the peculiar conformation of the digestive apparatus, and this is more especially so in the present instance, when the paunch is distended to a degree sufficient to prevent the entrance of any additional substance. At the commencement of the distention, a dose of olive or spermaceti oil will occasionally prove efficacious, but it is only in the early stage that it can be administered with any hopes of success.

But it has been said that the introduction of the probang into the rumen, in the case of hoove, is attended by an immediate and violent rush of gas through the instrument, and it is accordingly found serviceable in the removal of the gas. The rounded end of the tube is to be forced into the rumen, and it will produce partial relief, but the evolution of gas may still be going on. The stomach-pump will here be employed with good effect. By means of it, copious injections of warm water are thrown into the stomach, and again withdrawn; and the operation is to be repeated until all tendency to fermentation is removed, when the process of rumination usually commences, and the animal soon does well. Sometimes the rumen is so overcharged with fluid by the stomach-pump, that vomiting is induced, and a great portion of its contents is thus discharged.

The gas is sometimes completely withdrawn either by the probang or pump, but the tendency to produce an additional quantity still continues. In this case the administering of any substance that will combine with the gas as it is generated, without proving injurious to the parts with which it comes in contact, will afford immediate relief. This purpose is found to be effected by chloride of lime. The gas evolved during the different stages of the fermentation is found to consist of hydrogen, in combination with either carbon or sulphur, according to the period at which it is produced, but consisting essentially of hydrogen. The decomposition of the chloride is effected on its entrance into the stomach, the chlorine combining with the hydrogen to form muriatic acid, which, in its turn, enters into combination with the lime, and thus the gas is absorbed as fast as it is evolved. The chloride may be administered in doses of two drachms, dissolved in two quarts of water, and ejected into the paunch by means of the stomach-pump. This may be repeated an hour afterwards, if circumstances should seem to require it.

Cases of hoove sometimes occur, in which a more summary mode of treatment must be adopted. Frequently the fermentation has proceeded to such an extent as to threaten immediate danger to the animal before it has been perceived. In this case an incision may be made into the rumen at the left flank, which will afford immediate relief. The gas is speedily extricated in this way, and generally successfully so. But inflammation of a serious description may ensue from particles of the food escaping through the aperture in the rumen, and being deposited in the abdomen. To guard against this in some degree, an instrument called a trocar is employed for the purpose. It consists of a short, strong stillet, terminating in three cutting edges converging to a point, and having a handle that may be grasped with some force. To this is accurately fitted a canula, or tube, reaching from the termination of the three edges to the handle. This is plunged into the flank; the stillet is then withdrawn, and the canula remains as long as the operator pleases, and may be secured by tapes attached to two rings at the base of it, and tied round the body of the animal. In the absence of this instrument, however, a pen-knife, or other sharp instrument, may be successfully employed.

In making the incision with the trocar or knife, care must be taken that the instrument shall perforate the rumen, and that the spleen or kidney shall not be wounded. Supposing a line to be drawn close along the spine, from the haunch bone to the last rib, and two other lines of equal length to extend down the flank, so as to form an equilateral triangle, the apex of the triangle, or the points where these lines would meet, would be the proper place for the incision. After the rumen has been punctured, the animal must be kept on low diet for some time, and it must not be again extended by a large quantity of food until the wound has healed.

The animal having been relieved, and the gas ceasing to distend the paunch, a pound of Epsom salts should be administered, with an ounce of caraway powder, and half an ounce of ginger; and, on several successive mornings, four ounces of the salts, two of powdered gentian, and half an ounce of ginger, should be given. The object is to restore as speedily as possible the proper tone and action of the rumen. The return of the process of rumination will indicate when that is beginning to be effected, and rumination will usually precede the desire for food.

Diarrhœa and Dysentery. The frequent and abundant evacuations of fæcal matter, whether with or without mucus, may be considered either as simple, or connected with other diseases. In all these evacuations, it is of essential importance to observe whether mucus be present or not; for in the former case dysentery is present, in which, with the mucus, blood will frequently be mingled, and to effect a cure may often baffle the most skilful exertions. The latter is diarhœa, and is in general successfully treated.

Diarrhœa may be regarded as either acute or chronic. Acute diarrhœa may be produced by various causes; the abuse of purgatives, by their being administered in a too active form, feeding on certain poisonous plants, sudden change of food, excess of food, or by some peculiar state of the atmosphere. From the last cause it frequently assumes an epizootic character, particularly in the autumn. A great many cows in a certain district are suddenly attacked by it, although there is no reason to suspect that it is in the slightest degree contagious. It is more especially the disease of cows and calves, oxen being in a great measure free from its attack.

The treatment of acute diarrhœa will consist in the administration of a mild purgative in the first place, to carry off any source of irritation in the intestinal canal. The abstraction of blood, if there be any degree of fever, should take place, the quantity to be regulated in proportion to the degree of febrile action, and then the exhibition of alkalis and astringents. The most effectual medicines are prepared chalk, opium, catechu, and ginger, in the proportions of an ounce of the first, a drachm of the second, five drachms of the third, and two of the last, in each dose, which is to be administered in thick gruel. This treatment will generally be successful, unless the disease is of long standing, and has assumed somewhat of a chronic form.

Diarrhœa is not, however, always to be regarded as a disease. An occasional laxity of the bowels is known to be favourable to the acquirement of fat; and an animal that is well purged on being first turned on spring grass or turnips, thrives far more rapidly than another that is little or not at all affected by the change. In some critical stages of disease, it is to be hailed as the precursor of health, the object then being to prevent its becoming so violent as to depress the vital energies of the animal.

The treatment of chronic diarrhœa is often difficult and unsatisfactory. Having been sometimes in action for months, and even years, its removal becomes often a work of time and patience. Purgatives will be necessary; but they must be administered with caution, the quantity to be proportioned to the state of the animal. Castor oil will here be the safest and most effectual medicine, in doses from a pint to a pint and a half; and a small quantity, as ten grains, of powdered opium will not interfere with the aperient quality of the oil, while it may allay irritation. After a few doses of the oil have been given, the powder already recommended may be tried, but with a double quantity of ginger, and half a drachm of powdered gentian.

Dysentery may also be acute or chronic, and it is greatly more difficult of cure than diarrhœa. Its causes are frequently involved in obscurity, and its appearance cannot often be satisfactorily accounted for. There often appears to be a strong predisposition in cattle to take on this disease; and, whenever it appears, it rarely happens that the animal affected ever recovers its former healthy tone or condition.

When the disease has once appeared, it cannot well be mistaken. The presence of large quantities of mucus, often mingled with blood, sufficiently indicates the formidable nature of the disease. In acute cases, if it does not at once destroy the animal, it will be characterized by increasing dulness, disinclination to food, rapid decrease of condition, combined with violent purging. The increase of mucus too plainly indicates that of the disease, and the loss of this substance which lines the intestines exposes them to the most painful irritation. In this state the animal may remain for weeks, and even months, sometimes better and sometimes worse; but, in general, little well-founded hope can be entertained of his ultimate recovery.

The malady being of an inflammatory kind, the first measure to be adopted is bleeding, regulated by the age, size, and condition of the animal. The only case in which this measure, cannot be attempted is, when the animal is already in such a debilitated state, from long continuance of the disease, that the loss of blood might prove fatal; but the debility must be very great, indeed, when it cannot be advantageously adopted. A mild aperient may then be administered, with a view of removing a part of the cause of the irritation. The dose may consist of castor oil, in the proportion recommended for diarrhœa. Emollient injections will also be found useful in allaying the irritation, and restoring the intestines to their former healthy tone; and the beneficial effects of the injection will be further increased by the addition of half a drachm of powdered opium. A drachm of calomel has sometimes been combined with the opium with good effect.

An indispensable requisite in the treatment of this disease is, that the animal should be kept on bran mashes, or other food little stimulating in its nature. Green food is to be, by all means, avoided. After continuing this mode of treatment for some time, favourable symptoms will gradually appear, if there be any hope of a favourable termination of the disease. There will be a decreased quantity of mucus in the evacuations, and when this appears a favourable result may be anticipated. At this period, and not before, astringents may be resorted to with good effect. Chalk, catechu, and opium, with perhaps the addition of oak-bark, are to be administered. The beneficial agency of the chalk will be understood when it is considered that there is usually a tendency to acidity present in the stomach and intestinal canal; but the chalk will combine with and neutralize the acid, and thus render it harmless.

By long-continued and assiduous treatment, dysentery may be at length subdued, and apparently got rid of altogether; but the animal once affected by it is extremely liable to experience a return of the disease, and, therefore, should be disposed of as soon as circumstances will permit.

Constipation of the Bowels. This is a general accompaniment to many of the diseases of cattle, as well as of other animals, and, as a primary remedial measure, it is necessary that it should be removed. From the peculiar structure of the digestive apparatus, in cattle, this is often a work of difficulty. The medicine administered with a view of removing constipation may not reach the organ on which alone it could have any effect, and the dose is thus lost so far as regards the purpose for which it was intended.

The chief obstacle, then, to the removal of constipation in cattle arises from the difficulty of securing the entrance of the purgative into the abomasum, where, alone, it can have any effect. It sometimes occurs that double and treble the quantity calculated to produce an effect has been administered without the slightest indications of a successful result. In this case they should be accompanied by some aromatic, as half an ounce of ginger, and be given in as gentle a way as possible. There can scarcely be a better method than suffering it to run from a long narrow-necked bottle into the mouth. Should this not operate, a second dose must be given with an increased quantity of the aromatic, especially if fever be not present; and in the event of this being also without effect, another must be administered in order to get rid of the constipation. A cordial drink, containing an ounce of ginger and an equal quantity of carraway powder may probably be given with advantage; as the rumen may be roused to its natural action by the stimulus thus given, and a portion of its contents may be forced on to the abomasum. The use of aromatics and stimulants appears objectionable in a case where fever is present, as there must be a greater or less degree of fever attending violent constipation; but they are here absolutely indispensable as exciting to action, for purgation must be produced whatever may be the means employed. Back-raking and clysters will greatly contribute to produce this effect in conjunction with the aperients previously admiistered.

Red-water or Moor-ill. This disease, as its name indicates, is characterized by the colour of the urine, arising from a mixture of blood. It is one of very common occurrence, and often of difficult treatment, though it is not usually fatal. The causes of the disease have occupied the attention of breeders for a length of time, but they have not yet been satisfactorily accounted for.

In some seasons red-water is in a manner epidemic, and a great proportion of the beasts of certain districts is attacked by it. It is considered as peculiar to certain pastures, and an animal brought from a distance and placed on some of these is sure to be attacked. It usually occurs in woody districts, and particularly in low, marshy lands, although the frequency of its appearance in these does not seem to be well understood. The result of general experience is, that it has more to do with the nature of the food than with any other cause; and the production or the unusual growth of astringent and acrimonious plants may have considerable influence. The different species of crowfoot or ranunculus, and also the anemones, have often been regarded as the cause of the disease.

The first symptoms of red-water that are usually observed are, a discharge of bloody urine, and the appearance of general debility. Previous observation would have discovered the presence of unusual laxity of the bowels, but this has now changed into violent constipation, and, as soon as this constipation is established, the coloured urine appears. The disease often runs its course with fearful rapidity, and the animal is sometimes destroyed in a very few days, when its progress has not been arrested. When the carcass is examined there is generally found some inflammation of the kidney, and in cows, the uterus exhibits much inflammation, often accompanied by extensive ulceration.

The disease, is regarded as an affection of the kidneys, arising from the determination of an undue quantity of blood to these organs, and the consequent production of much local inflammation. Bleeding, therefore, will be the first step indicated by the nature of the disease, but this is to be performed with extreme caution. The effect of the bleeding will be a diminution in the quantity circulated through the system, and giving a different direction to that excess from which the inflammation proceeded. Purgatives should then follow, to restore the impeded action of the bowels which has contributed much towards the virulency of the disease. In all cases of violent constipation it has been seen that the bowels are not easily acted on in cattle, and this will be found to be so in the present case. Dose after dose must, however, be administered, as the successful treatment of the disease will depend in a great degree on this; and if the bowels continue insensible to the action of the repeated doses, aromatics must be administered with a view of exciting them, even notwithstanding the presence of a slight degree of fever.

The constipation is the main object to combat, and, in addition to purgatives, copious and repeated injections should be administered. Much of the hardened fæcal matter may be removed by the rectum, which will give additional efficacy to the injections and purgatives, and, probably, enable them to open the bowels. Without this is effected, indeed, all other remedies are fruitless, and the animal will certainly perish.

Notwithstanding the frequency and formidable nature of this disease, many farmers never lose an animal by it, while others sustain losses from it every season. This may be accounted for from the greater attention paid in the one case than in the other. No serious obstacle is presented in the way of effecting a cure during the first stages of the disease, but when it has continued for some time, it may baffle the most skilful exertions. It should, therefore, be attacked in its earliest stage.

Diseases of the Skin. Under proper treatment, the diseases of the skin are not numerous; but, owing to bad management, they sometimes make their appearance and prove a source of annoyance.

The skin of cattle, physiologically considered, differs little from that of the horse. The state of the skin, in the horse, is attended to as a criterion of the state of health of the animal, and it is equally deserving of attention in cattle. It is well known to the farmer, that the animal whose skin is not soft, mellow, and elastic, can never be profitable for feeding, therefore he judges of the value of the animal even more by the handling than by any peculiar conformation.

Hide Bound. This condition of the skin is the result of the deficiency of the natural secretions, and is deserving of attention, as indicating some other deficiency or disturbance of the system. It is accompanied by a rough and staring coat, and a general want of that mellowness and softness which has just been mentioned.

When this unthrifty state of the skin appears, the condition of the animal should be narrowly examined, as it is seldom or never a primary affection, but is the result of some other long-continued disease, the removal of which will restore the skin to its former healthy condition. But if it cannot be traced to any evident cause, still there is not the less doubt that something is wrong. A dose of physic should be given, which may consist of half a pound of sulphur, with half an ounce of ginger, and a few mashes should be allowed. After this, medicines should be administered which have a tendency to rouse the vessels of the skin to their due action, as sulphur, nitre, and antimonial powder, with a small quantity of ginger, which will in most cases have the desired effect.

Mange. This is a serious and annoying disease. The symptoms are well known and can rarely be mistaken. An excessive itchiness, with an inclination to rub against anything in the way, the loss of hair on various parts of the body, a thick scurfiness of the skin, particularly along the back, and in patches in several other places, and a general loss of condition, but too plainly mark the disease.

The causes of mange may be various, and occasionally as opposite as it is possible for them to be. Too luxuriant food will produce it, and it will as certainly follow starvation. The skin sympathizes with the over-taxed powers of digestion in the one case, and with the general debility of the frame in the other; and nothing is more certain of bringing it on than the sudden change from comparative starvation to luxuriant food.

On the appearance of the disease, the animal should be removed from the others, and as much of the scurfiness of the skin removed by a hard brush or comb as possible. Repeated applications of the following ointment should be well rubbed in, and they will generally effect a cure. Half a pound sublimed sulphur, two ounces of common turpentine, two ounces of strong mercurial ointment, and a pint of linseed oil, to be thoroughly incorporated together. The treatment should not be confined to external applications. Sulphur, in doses of half a pound every third day, will materially assist in effecting a cure; and in the intermediate days the powder recommended for hide-bound may be given.

A usual accompaniment of mange is lice. When these are found on an animal, he should instantly be removed from the others, as it is surprising how rapidly these insects multiply, and distribute themselves over a whole flock, by the mere contact of the animals. The most convenient and effectual application is mercurial ointment, which must be well rubbed in along the spine, from the head to the tail, and in streaks along several other parts. It is not, by any means, necessary that the animal should be altogether rubbed over to effect a cure.

Angle Berries or Warts. These are excrescences growing from the cuticle at first, but afterwards identified with the true skin. They assume various forms, from that of scales of greater or less thickness, to fungous lumps of great size and hardness, and often prove a fruitful source of annoyance to the animal. When they have attained a large size, they may be removed by passing a ligature round their roots, or recourse may be had to the knife, and the cautery will stop the bleeding, and destroy the roots of the warts.

The principal diseases incident to cattle have now been described. Certain others will, however, sometimes occur, and the mode of treatment will, in general, be the same as that recommended for similar diseases of the horse. Those belonging especially to cows and calves will be afterwards considered.

IV.—THE REARING AND FEEDING OF CATTLE.

Cattle do not attain their full size until they have completed their fourth year. It would, therefore, seem that they should not be employed for the production of their species until that period, but in practice this is rarely the case. There are indeed many instances of the female producing a calf before the completion of the second year. The practice of not allowing heifers to receive the male until they are four years old, or near that age, is reprehensible, on the score of economy, as the animal has been kept much longer than was neccssary without making any return; but that of allowing the male to have access to the females by the end of their first year is equally reprehensible, for, at the time they are most rapidly growing themselves, a sufficient quantity of nutriment cannot be devoted to the full development of the fœtus, and the mother and the calf must each inevitably suffer. The proper time, therefore, is as soon as the animal can devote the necessary portion of nutriment for the fœtus without materially interfering with her own growth. This appears to be between the second and third year, so that the male may be admitted after the female has completed her second year.

It is equally improper to use the male at too early an age for the purpose of reproduction. He will, in this case, be deprived of much of his natural energy, and never afterwards attain to the size he would otherwise have reached, besides the progeny will be inferior. He may be employed, in a few cases, at two years' old, and at the termination of his third year he will have attained to his full strength and vigour.

The propriety of separating the male from the female stock thus is apparent. This arrangement secures the young heifers from being employed as breeders at too early an age, and also guards against impregnation at a time when the corresponding period of parturition would be inconvenient. It also enables the farmer to secure the calving of his cows at the periods that best suit his pastures, or his arrangements.

The usual period of gestation in the cow is about forty weeks, varying somewhat according to the constitution of the animal. It seldom happens that more than one is produced at a birth, but sometimes two are produced; in which case, if one of them be a female, she is usually considered incapable of procreation, although the bull is perfect. A few days after calving, the cow again manifests a desire to receive the male, and this inclination returns at periods of about a month distant, until impregnation takes place.

Some time before the period of parturition, it is usual to allow the secretion of milk to stop, in order to prevent inflammation, from the new secretion and the old one both going on at the same time. The length of this period must depend on the condition of the cow, as one that has been well fed may be milked to within a few weeks of the time of calving, but a greater length of time must be allowed to the poorer cow.

The natural progress of parturition should not be unnecessarily interfered with. The cow should be attentively watched, but not disturbed. Although the pains of labour may not be so strong as could be wished, she should not be too closely approached or examined, until a part of the fœtus is protruded, when it will be necessary to ascertain that it is coming in the proper position. In the natural presentation, the head is crouched between the fore-legs, and reaching down as far as the knees, and the back of the calf corresponding with, or opposed to, the back of the mother.

While the throes continue tolerably strong, the farmer must have patience, although the progress of parturition may be tediously slow. Nature will at length, in most cases, safely accomplish the object. But if the pains be evidently diminishing, and hour after hour has passed, and the calf protrudes little, or not at all, more than it did, assistance must be rendered. A pint of good ale, warmed, should be given in an equal quantity of gruel; warm gruel should be frequently administered, or, at least, put within the animal's reach; and access to cold water should be carefully prevented.

Should all prove unavailing, recourse must be had to mechanical assistance. Twelve hours or more having elapsed from the commencement of the labour, this should be done, although the calf may be still alive; and it should not be delayed a moment after it is ascertained that it is dead. Even now, however, the cow should not be disturbed more than is absolutely necessary. She generally confines herself to the lying posture, and in this position she should not be disturbed until she is safely delivered of her young.

When the head is sufficiently advanced to be grasped by the hands, or for a hand to be introduced by the side of it, so as to urge it forward, an assistant, at the same time, laying hold of the fore-legs, and pulling with moderate force at each of the throes of the mother, the little animal may often be brought forward without endangering its life. If, however, it be firmly impacted in the passage, a cord with a slip-knot should be fastened around each leg, immediately above the fetlock, and a third cord around the lower jaw. Greater power may then be applied, the persons holding the cord pulling in concert, accommodating themselves to the natural pains of the mother, and exerting their strength, although somewhat forcibly, yet quietly and gradually. If the fœtus cannot be extracted by moderate force, one of the shoulders should be taken off, which may be effected by means of a small knife, curved like those used for pruning, so as to be easily introduced into the passage in the hollow of the hand, and there used without danger of wounding the cow. The shoulder being detached and removed, the bulk of the calf will be materially lessened, and the remainder will be extracted without difficulty. The operation of taking off the shoulder is simple, but, in most cases, it is better that it should be performed by a regular practitioner.

It will soon be evident whether the calf is in the right position. The appearance of the feet and the situation of the head will be satisfactory on this point; but, in some cases, the position may be such, that it will necessarily be retained until a change be made. The throes of the mother must not, therefore, be allowed to continue without satisfactorily determining this point. It will sometimes occur that the position is such, that the animal cannot be removed into a more favourable one; and, in this case, different parts of the calf should be successively removed with the knife, as the safety of the calf is a small consideration in comparison with that of the mother.

Parturition having been accomplished, the calf is to be carried away and placed loose in a pen or crib, with clean dry litter. The cow should not be suffered to touch or recognize her young, as this only tends to render her uneasy and distressed by the separation. It is, however, generally recommended that she should be allowed to lick the calf after birth, which she invariably evinces a disposition to do, and the friction thus produced is advantageous to the calf, as increasing the languid circulation of the blood, and producing a genial warmth. But, for the reason stated, it does not seem prudent to allow the mother to recognize her young, unless when it is intended that she should suckle it.

At this period the cow is necessarily much exhausted, and requires warm and nourishing food. A warm mash should be put before her, and warm gruel, or water from which the coldness has been taken. A few hours afterwards it will be prudent to administer an aperient drink, consisting of a pound of Epsom salts and two drachms of ginger. This may tend to prevent milk fever and garget in the udder, which are now liable to take place.

The placenta, or cleansing, should be discharged soon after calving. It soon begins to act upon the uterus, when retained, as a foreign body, producing irritation and fever; it also rapidly becomes putrid, and if it be retained long there, it is an indication of a weakly state of the cow, and may produce a certain degree of low fever that will materially interfere with her condition. The aperient drink recommended after calving, with the addition of half a pint of good ale, may be beneficially administered.

Although parturition is a natural process, it is attended by a great deal of febrile excitement. The sudden transference of powerful and accumulated action from one organ to another must cause a great deal of constitutional disturbance, as well as liability to local inflammation. The cow, accordingly, after parturition, is subject to inflammation of some of the parts, the functions of which are thus changed; it is mere local inflammation at first, but the system speedily sympathizes, and puerperal fever appears. Cows in high condition are most subject to this disease. Cows are also comparatively seldom attacked with milk fever at their first calving, because, in this case, they have seldom attained their full growth, and they are not then so liable to inflammatory diseases. The treatment consists in copious bleeding and purgatives, after which the usual sedative medicines may be given.

Inflammation of the udder sometimes appears after calving. The new and increased function which is then set up, and the sudden distention of the bag with milk, produce tenderness and irritability of the udder, and particularly of the teats. This, in some cases, shows itself in the form of excoriations, or sores, or small cracks on the teats. Much pain is produced in the act of milking, and the discharge from the sores frequently mingles with the milk. When these appear, the teats should be immediately fomented with water, in order to clean them, and get rid of a portion of the hardened matter about them, the continuance of which is the cause of the pain in milking. They should afterwards be dressed with an ointment composed of an ounce of yellow wax, and three of lard, melted together, and when they begin to cool, a quarter of an ounce of sugar of lead, and a drachm of finely powdered alum are to be added.

But, occasionally, inflammation of the udder assumes another and more dangerous character; it attacks the internal substance of that organ, and hardened tumours are soon felt, which are exceedingly troublesome to remove. The retention of the milk serves still further to increase the inflammation, and not unfrequently the use of one or more of the teats is lost before the inflammation is subdued. The animal must be bled and physicked, after which the part is to be well fomented, and the milk drawn gently and repeatedly off. An ointment composed of the following ingredients should be thoroughly rubbed into it by the hand. Rub down an ounce of camphor, having poured a teaspoonful of spirits of wine upon it, and add an ounce of mercurial ointment, and half a pound of elder ointment. These are to be well incorporated together, and applied after every milking, the udder being well fomented with warm water, and the remains of the ointment washed off before next milking. Should the indurations come to suppuration, the use of the lancet will be indispensable; and, after the matter is discharged, the treatment will be similar to that of wounds in general.

These diseases of the udder sometimes prove a source of great annoyance; but, in most cases, cows are free from them, and careful and judicious treatment on the part of the dairy-maid will operate as a preventative to many of them. The operation of milking should be repeated at such frequent intervals as to guard against distention of the udder from the retention of the milk; and it is especially important that every drop of milk should be removed from the udder at each operation, for when this is not the case, a rapid falling off in the quantity produced will take place.

It is important to the breeder of cattle that the calves should be produced at a season when a full bite of grass may be obtained for them as soon as they are able to use it. In this respect the proper time would be during the months of January, February, or March, and by the time the calves are weaned the pastures will be ready for them. But other considerations sometimes influence the proper time of calving, such as the time at which it is desirable to have a full flow of milk; and in districts where green food is not raised in abundance, the farmer endeavours to have the greater number of his cows to calve at an advanced period of the season, so as to prevent the falling off in the milk before the pastures are ready for the cows.

The milk produced immediately after calving is of a yellow colour, and has a viscid appearance. It is eminently calculated for the yet weak condition of the digestive organs of the calf, and should be given to it in preference to the milk of any of the other cows. The practice of substituting milk from the general stock for that of the mother is often productive of a diseased state of the digestive organs. This is done from an erroneous opinion that the milk first produced after calving is too strong for the stomach of the calf; but that which is naturally provided for it is certainly the most suitable.

Calves are frequently reared by suckling, and when it is wished to rear animals of the best description, without any regard to economy of milk, this system may be adopted. The more usual plan, however, is to feed them from the pail, observing to give them as much milk as they can consume. This will be found to be somewhat more than a wine gallon in the day, at first, and it will be increased gradually to two gallons and a half or more. When the calf is about a month old, a portion of milk may be withdrawn, and various other matters added, such as meal boiled with water, and linseed jelly. The milk should be given to the calf immediately after being taken from the cow, but a portion of skimmed milk may be substituted at the end of two months, and in three months, it may be fed on skimmed milk altogether. The quantity after this will be gradually decreased for another month, after which, the calf may be weaned. Before this time it will have learned to eat grass, and should the season not be sufficiently advanced for that purpose, a bunch of sweet hay is to be placed within reach, which the young animal will soon learn to eat.

The flesh of the calf at an early period forms a much esteemed and nourishing article of food, and in districts where a demand exists for it, these animals may be profitably disposed of for this purpose. In certain districts in England and Scotland the fattening of calves is extensively practised, and forms at once a convenient and profitable method of disposing of the milk as well as of the calves. Mixtures of farinaceous matters are sometimes combined with the milk for this purpose, with a view of bringing the animal sooner ready for the market; but in the district of Strathaven, where the fattening of calves is probably brought to greater perfection than in any other part of the kingdom, no such mixtures are made, the food consisting of milk alone.*

The object being, in this case, to bring the calf to the required degree of fatness within the shortest possible space of time, as much milk should be allowed as it can consume, and new milk alone should be employed. It is also the practice to give the milk first drawn off to the calves intended for rearing, and the last drawn-off milk to the fatting calves. This is, perhaps, less economical feeding than most persons would be willing to practise; but it must be remembered that the growth of the calf, and the degree of fatness to which it may attain, depend on the quality of the food as well as on its quantity.

Essential requisites in the fattening of calves are strict cleanliness, and a certain degree of seclusion from the light. They should be plentifully supplied with dry litter, and the bottom of the stand or calf-pen must be contrived so as to afford every facility for conveying away the urine. The absence of light makes the animals less sportive than they would otherwise be, and preserves them from accident through playfulness. The utmost regularity is also to be observed in the hours of feeding, for when they are not supplied with food at the accustomed hour they remain in a state of uneasiness until they are fed, and every thing which tends to render them uneasy is to be carefully guarded against.

The age at which the calf is ready for market is between the fourth and tenth week. It cannot be disposed of to advantage before the former of these pariods, as the flesh is innutritious and unpalatable; but when kept after the latter period it loses that sweetness and tenderness for which it should be distinguished. A good calf will weigh from sixteen to twenty stones at the age of ten weeks, and will therefore make a sufficient return for the milk consumed.

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* Aiton's Agriculture of Ayrshire, p. 443.

When calves have been properly treated they will seldom be attacked by diseases. Those to which they are subject are constipation of the bowels, and more frequently the opposite condition, diarrhœa.

Constipation is not a frequent disease of calves, but it is occasionally seen, and is extremely injurious. The first milk yielded after calving, or beastings, as it is termed, possesses an aperient quality, and is admirably suited for the young animal; but when, instead of this, the milk of another cow is given, constipation will sometimes follow. Castor oil is the safest and most effectual aperient for so young an animal. It should be given mixed up with the yolk of an egg, or in thick gruel, in doses of two or three ounces; and, even at this early stage, the carminative which forms so useful and indispensable an ingredient in the physic of cattle should not be omitted—a scruple of ginger should be added to the oil.

A tendency to costiveness in a calf should be obviated as speedily as possible. It is inconsistent with the natural and profitable thriving of the animal, and it can never long exist without inducing a degree of fever always dangerous, and generally fatal.

The disease, however, to which calves are most liable, and which is most fatal to them, is purging. This results from a variety of causes. It is the result either of starvation or excess—it is the almost necessary consequence of a sudden change of diet; in fact, it is occasionally produced by every thing that deranges the process of healthy digestion.

A certain degree of looseness of the bowels in the calf is present even in a healthy state, and is not at all unfavourable to the thriving of the animal, especially when it is as lively as usual, and manifests the usual eagerness for its food. But when this continues, and the health of the calf seems to be affected, and mucus or perhaps blood is mingled with the excrement, the constitution will soon be affected, and the most prompt and vigorous measures are to be used. A mild purgative, consisting of two ounces of castor oil, or three of Epsom salts, should first be administered to carry away the cause of the disturbed state of the bowels. To this should follow anodyne, astringent, and alkaline medicines, with a mild carminative. The whole will consist of opium, catechu, chalk, and ginger, the proportions of which will be found in the treatment of diarrhœa, as a disease of cattle. The use of this mixture should be accompanied by frequent drenching with starch or thick gruel. Bran mashes, with a little pea or bean meal, may be given, and all green and acescent food are to be carefully removed.

The males not intended for propagating may be castrated when about a month old, as there is much less danger attending the operation at this early period than when it is longer delayed. It is easily performed by two incisions into the scrotum, through which the testicles protrude, and are removed by cutting the cords by which they are respectively appended.

The subsequent treatment of calves necessarily depends upon the nature of the farm, and the species of food which can be supplied. Where there is nothing but coarse pastures and inferior hay, and where no turnips or cultivated forage can be raised, then the stock of the farm must be suited to these circumstances. In such cases the breeders are merely the rearers of the animals, which, when they have reached a certain age, are disposed of to another class of farmers, who have the means to feed them. A great proportion of the lands of the country is better suited for breeding in this manner than for feeding; and a large exportation of animals takes place, from all the breeding farms and districts, to be fed elsewhere. The feeders purchase the cattle at such ages as suit their purposes, and keep them on their farms for such periods as they find expedient. This is a division of labour in the breeding and feeding of cattle perfectly natural, and in an eminent degree favourable to the interests of individuals and the country. It is in this manner that each district and farm is applied, with reference to the production of live-stock, to the purpose to which it is best adapted.*

It is essential that the pastures on which calves are fed during the first season should be of a good description, both as producing a full bite and supplying nutritious herbage. When the pastures begin to fail in the autumn, which will generally be in the end of October or beginning of November, the animals are brought into the straw-yard or other place, in which they are to remain during the winter. They are sometimes brought into houses and confined, as in the case of the older cattle; but the preferable practice is to put them in yards with sheds into which they may retire for shelter, as the young animals are found to thrive better when at liberty than when confined. The straw-yard is separated into divisions in which a certain number only is put, and this number should not be too great, though this is less important at this period of their life than afterwards. Calves to the number of twenty may be kept in one enclosure, provided they have plenty of room; but in most cases, and especially when they are of some of the larger breeds, it is better that the number of animals put into each yard should not exceed ten or twelve.

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* Elements of Practical Agriculture.

The straw-yard in which the young cattle of the farm are kept is important as affording the means of converting the straw not required for other purposes into manure, as well as affording shelter and room for exercise to the animals. But it is for the latter purpose that it is the more valuable, and for this reason the arrangements for supplying them with food and shelter should be the most convenient that circumstances will admit. The usual object of the straw-yard in the management of cattle is merely to maintain them in the condition in which they came from the grass, but it is better that this should be improved at every opportunity. For this purpose green food should be supplied liberally. The calves should receive an allowance of turnips, in the morning, again at noon, and, lastly, in the evening, before night-fall.

As soon as the grass has made such progress in the spring as to afford a full bite, the young cattle are to be turned out of the yards, to the pastures. This will generally be about the beginning of the month of May, or perhaps a week or more later or earlier, according to the season. They should not, however, be turned to grass until it is sufficiently forward to support them without any falling off in condition; and it is also necessary to guard against overstocking. The young animals should at no period be allowed to fall off in condition, and it is more necessary to attend to this precaution at this period of their growth, than when further advanced. Young cattle which have been stinted in their growth by an insufficiency of food, seldom turn out well. At the period of being turned out to grass, to which reference has been made, they will have completed their first year, and are, in the language of farmers, yearlings, or one year old.

The young animals are now kept on their pastures during the summer, and when the grass begins to fail in the autumn, they are taken up as before, and put into yards with sheltered sheds; but having increased in size, a smaller number is to be put together, as they are apt to interfere with one another in feeding. The treatment should be the same as in the last winter—they are to be well littered, to be fed three times a-day with turnips, and to be plentifully supplied with straw.

In the practice of feeding young cattle, this is the period at which a slight relaxation may be made, with the least interference with the growth and condition of the animals; not that any such relaxation in the system of full feeding can be regarded as a general rule, as it should be the object of the farmer, to maintain his young cattle at all times in the best condition that circumstances will admit. They should therefore be kept, if possible, at all times from the period of birth until they are finally disposed of, not only growing, but fattening; but if this system cannot be carried fully into effect, the second winter is the period at which the supply of green food may be limited, observing, at all times, to supply them plentifully with dry provender. As a general rule, however, it is better that the number of animals should be reduced, than that they should be stinted in their food; and it is especially important to take care that they shall not, at any time, lose flesh, it being opposed to the true principles of feeding, to allow animals at any time to fall off in condition.

In the case of the finer breeds, the animals may now be prepared for the butcher; for which they will be ready in the following spring, after being fully fed during the winter, or having been fed some time on grass in the commencement of the following summer. This is the perfection of rearing and feeding cattle, and the practice shows how great must be the superiority of a breed that can be fattened at this early age. It is, however, only the finer classes of animals, and that under a perfect system of feeding, that can be thus early matured; and the more common case is, that they require one winter's feeding more before they are ready for the butcher.*

It is not necessary, however, after the first winter, to give the same high feeding to the females intended for breeding, as to the males, and also to the females intended for the butcher. The object proposed with the females intended for breeding, is not to render them fat, but to maintain them in a healthy and growing state. This is to be done, not by giving them a full allowance of the richer food, but such a portion of it only, as, joined to the more common provender of the farm, will maintain them in a healthy state. When the yearling steers are to be carried on during their second winter on a modified, and not a full, allowance of richer food, then the heifers need not be separated from them, because both are to be fed in the same manner; but when the steers are, at this time, to receive full feeding, then the heifers are to be put into a yard by themselves. They should not be tied to stakes, according to the common practice, but kept in yards with sheds. In the following summer, they are pastured along with the older cows, and receive the male as soon as they are ready to do so, which, in the case of heifers, is later than in that of older cows. When winter comes, they are to be put into their separate yard again, and fed as in the first winter, and when within a few weeks of the period of calving, they may be tied up in their stalls like the older cows.*

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* Elements of Practical Agriculture.

At the termination of the second winter, the animals are removed to their pastures as before, where they remain during the season. On the approach of winter they are again taken up and fed on the fullest quantity of green food which they can consume, as they are now being prepared for the butcher. In this final feeding, two methods may be adopted:—the animals may either be tied in the house, and there supplied with food, or they may be kept in open yards with sheds, as in the preceding winter.

When the animals are fed in the house, they are said to be stall-fed, and the management and attendance of them in this case require the utmost attention. It is important that the person in charge of them should observe the strictest punctuality, even to a minute in the hours of feeding, as the animals know perfectly well when the accustomed hour of feeding arrives, and become restless when they are disappointed. This strict adherence to the particular hour for the performance of the work will also be found to economize time, and leisure will be obtained for the performance of sundry operations in and about the cattle sheds, which contribute to neatness and cleanliness.

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* Elements of Practical Agriculture.

On entering the feeding-house in the morning, the first operation is to supply the cattle with turnips; and, while they are consuming them, the dung is to be removed from behind them, and put out of the house, to be afterwards conveyed to the yard or pit containing the manure. When the turnips are eaten up, the animals are to be supplied with a little straw or hay, and being now well littered, they will soon lie down and chew the cud. At noon they are again to be fed as before, and again in the evening, always observing to place some straw or hay before them after each meal. Before retiring to rest the attendant examines the state of the cattle, and sees that everything is right; adjusts the litter if it be displaced, and supplies them with a small quantity of provender.

During the intervals between the meals, the animals should not be disturbed, as they invariably incline to lie down after feeding. The attendant must carefully and repeatedly examine them to ascertain that they are free from lice, and otherwise in perfect health; and he must use the curry-comb liberally, in order to allay that titillation in their skin, which they would do themselves, were they placed at liberty. During the time of feeding careful inspection is also necessary, so that should any of them be choked by a piece of a turnip, the circumstance will be immediately observed, and the proper remedies applied.

When the feeding animals are kept in the yards, the principle of feeding is not materially different from that described. The dung is not, of course, removed during the hours of feeding, being in this case covered with an additional quantity of litter; but the like exactness should be observed in the hours of supplying the animals with their food.

In the management of feeding cattle, it is important that the straw or hay which is given to them should be of the best quality, and free from any injury caused by too long continued exposure to the weather, or other imperfect management. The turnips are supplied without any other preparation than the stems and tap-roots having been cut off, and such particles of loose earth as may have adhered to them in the act of raising them up, removed. Frequently, however, they are cut into slices by the turnip slicer; and this is more essential in the case of the young animals than of such as are older, as they experience greater difficulty in biting large turnips; and, especially at the period of their being first supplied with these roots, it is important that they should be sliced, until the animals become accustomed to them. The white turnips are supplied at the commencement of the feeding season, and these, decaying as the season advances, are to be succeeded by the yellow sorts, which, in their turn, are succeeded by the Swedish turnips. These finish the feeding season. When taken up before vegetation becomes active in the spring, they retain their nutritive juices until a late period of the season, sometimes, indeed, to the end of the month of May.

In the practice of feeding cattle with turnips, it is usual to bring the roots from the field as they are consumed; but a store should be at hand throughout the winter to supply the animals in stormy weather, and at such other periods as it might not be convenient to carry them from the fields. When the frost becomes so severe as to harden the turnips, they should not be brought any longer from the fields, but from the store; nor should any more be taken even from the store than can be consumed in a day. Frozen turnips may, however, be thawed, by placing them in cold water; but this is a very tedious and troublesome mode of obtaining turnips in frosty weather, and not at all comparable to the convenient and excellent practice of storing a considerable quantity while the weather is open.

Turnips form at once the most simple and economical food on which cattle can be fed in this country during the winter. They are raised with facility and economy, and are also supplied to the animals with little trouble. Turnips, however, cannot in all cases be raised in sufficient quantity, and recourse must be had to other substances. These will, in ordinary cases, be the various other roots cultivated on the farm.

The beet, carrot, parsnip, and cabbage, are all suited to the purpose of feeding, and the manner of consuming them is similar to that of the turnip. The carrot and parsnip are, indeed, in an eminent degree, nutritious, and supply a valuable food for fatting cattle; but they are seldom raised in sufficient quantities for this purpose, and, in the practice of the farm, they are chiefly given to horses.

Potatoes also are well suited to the purpose of feeding, though greatly inferior in many respects to the turnip, being raised at much greater expense, and more dangerous in the application. They may, however, be combined with turnips for feeding, and this system has been found to promote the tendency to acquire flesh. Potatoes are at all times to be given with caution, as at first they are very liable to purge the animal. They may be given steamed with good effect.

These are the substances employed for feeding, which are the produce of the farm. Local circumstances, however, give a peculiar value to several other substances for feeding. Such are the refuse of the distillery and of the oil-manufactory, and various other substances which need not be enumerated here.

Salt should be given to feeding animals. They will soon learn to take it if placed within their reach, and a simple and convenient method of supplying it is to place a lump of rock salt before them, which they will lick occasionally.

V.—WEIGHT OF CATTLE.

To judge accurately of the quality and weight of live-stock is an acquirement which every farmer is desirous to possess. It is, indeed, the highest accomplishment which a breeder of stock can acquire; for by it he can never fail to maintain them in the highest perfection. It is an accomplishment, however, which can only be acquired by very extensive experience and careful observation.

In the disposal of his cattle, the farmer who is unable to form an accurate idea of their weight, labours under a great disadvantage, and this disadvantage is still further increased when he considers that the buyer is a perfect judge from long experience. The gross weight of the animal is, indeed, easily ascertained by simply weighing it in a common weighing machine; but in this case the proportion which the more valuable parts bear to the entire weight is to be taken into consideration. But, in the absence of a weighing machine calculated to ascertain the weight of large animals, the same purpose may be effected by admeasurement, and a series of calculations founded on experience.

The first object of inquiry, then, is to ascertain the proportion which the more valuable parts of the animal bear to the less valuable. The latter are included under the term offal, and consist of the head and feet, the tallow, the hide and horns, and the entrails; the value of which is usually equal to that of one of the quarters.

In ascertaining the proportion which the live weight of the animal bears to the dead weight, the four quarters only are taken into consideration. The latter were long considered to amount to just one-half the whole gross weight; but experience, from repeated trials, showed that this proportion was much too small, and that the weight of the quarters, in reality, was more than half the gross weight. The result obtained from a number of trials with a view of determining the precise proportion, is, that if the whole weight of the animal be represented by 1, the weight of the quarters will be .605; and therefore the dead weight is ascertained by simply multiplying the live weight by this number. The number .605, however, can only be regarded as a near approximation, for the result will vary in different animals.

When the weight is to be ascertained by measurement, the body of the animal is regarded as a cylinder, and the mode of calculation is founded on that assumption. In order to find the area of a cylinder, the length and either the diameter or circumference are necessary dimensions; and these, accordingly, are the dimensions taken of the animal. The animal being standing in a natural position, the girth or circumference is taken immediately behind the fore-legs, and the length is taken from the foremost upper corner of the shoulder-blade in a straight line to the hindmost point of the rump. As in the case of the cylinder, then, the square of the girth, multiplied by .07958,* and this again by the length, will give the number of cubic feet in the animal. But a cubic foot is found, from experience, to contain a given weight; however, instead of using the proportion which a cubic foot bears to the gross weight, the proportion which it bears to the quarters is employed, and this is found to be 2.993 stones; that is, for every cubic foot the animal measures he will weigh so many times this number of stones. The weight of the quarters, in imperial stones, is therefore found by multiplying the contents in cubic feet by the number 2.993.

This operation, however, for calculating the weight, may be much shorted. As .07958 and 2.993 are both constant multipliers in the operation, these numbers may be multiplied together, and the product used as one multiplier;—thus, $.07958 + 2.993 = .23818294$. But .238 only may be taken as the multiplier, without incurring an error exceeding half a pound in the medium size of cattle. Hence the rule for ascertaining the weight of an animal by measurement is to multiply the square of the girth taken behind the shoulder by the length, and this product by the decimal .238, which will give the weight of the four quarters in imperial stones very near the truth.

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* This number is the area of a circle whose circumference is unity.

Such is the mode of determining the weight of animals of the ordinary state of fatness; but there are certain circumstances to be taken into account in particular states of the animal. In the case of very fat animals, one-twentieth part should be added to the weight obtained by measurement and calculation; and, when below the ordinary state, the same proportion should be deducted. A bull, from having more flesh upon the neck, should have, perhaps, one twenty-fifth part added; and, in the case of old milch cows which have had a number of calves, a twelfth part should be deducted.

When the weight of any animal has been ascertained by the rule, the other items, as tallow, hide, and other offal, must also be taken into account. These, particularly the tallow, differ materially in the different sizes, breeds, and ages of animals, all of which must be kept in view in making up the estimate. The tallow is generally considered to be of the same value, weight for weight, as the flesh of the four quarters; and so, likewise, is the hide. By calculating the market price per stone of the four quarters thus ascertained, and adding to it the value of the other parts, the total value of the animal will be found.

VI.—THE DAIRY.

Milk is a fluid secretion peculiar to the females of the class *Mammalia*, or those animals which suckle their young. It takes place in some of them only during and after the time of gestation; but, in the case of the cow, it is continued for a length of time after the wants of her young are supplied, and hence the value of this animal to the human race. As it comes from the cow, it is composed of three substances, namely, an oily or butyraceous matter, a lactic or caseous substance, and serum or whey, all in mechanical combination. These are separated by the operations of the dairy, and each of them converted to its proper use as human food.

By the agitation of milk it is separated into two substances, a fluid and a solid. The solid part is butter, having all the properties of an expressed oil. The butter is distributed through all the substance of milk in very small particles, being suspended by a slight adhesion, but without being dissolved. It is in the same state in which oil is in emulsions, and, by rest, the oily particles separate from each of these substances to come to the surface and form cream. When butter is in the state of cream, its proper oily parts are not yet sufficiently concentrated to form a homogeneous mass. Being separated by the interposition of a large quantity of serous particles, the butter cannot be completely formed; but by pressing out these heterogeneous parts by means of continued percussion by the well-known operation of churning, it then becomes a uniform soft mass. The fluid part remaining is merely the milk deprived of its butyraceous part; and is now termed buttermilk.

After milk is drawn from the cow and left at rest for some-time, it coagulates, and is resolved into two substances, differing essentially from each other—curd and whey. It is from the former of these substances that cheese is made, and the latter is milk deprived of its caseous matter. Although the coagulation of the milk will take place thus spontaneously, it is usual in practice to hasten the process by the addition of substances known to coagulate fluids containing albumen, such as acids, alcohol, and the gastric juice of animals, the latter being the coagulum in common use.

It is from the cream alone that butter can be formed; and that is done by churning or agitation, either of the whole mass of the milk, or of the cream only. As the preparation for churning is different in these cases, it becomes necessary to describe both, so as any person in the least acquainted with the qualities or management of milk, may understand how to extract the butter it contains by either process. In the first case the butter will be obtained in larger quantity; but, in the second, it will be of a superior quality.

In like manner, the caseous or cheesy matter may be obtained from the whole of the milk, or from the cream alone. In the latter case, a cheese of surpassing richness is produced; but the quantity being much smaller than in the former case, it is seldom practised. Cheese is also produced by coagulation of the skimmed-milk after the cream is removed; and, although not greatly deficient in quantity, it is of very inferior quality.

The milk, when drawn from the cow, is placed from six to twelve hours in coolers, the same as when set aside to cast up its cream, but this is merely to let the milk cool. And whenever it is completely divested of its natural heat, the whole meal of milk is emptied from the coolers into a stand-vat, or vessel sufficient to contain the whole. If the vat is large, and a second meal of milk has become cool before the former meal has begun to acidify, the second may be turned into the same vat with the first. But, if the first has in the least become sour, or is found to be approaching to acidity, the second meal of milk is put into another vat by itself, to prevent its being soured otherwise than in its own natural course. A lid or cover is thrown over the vat which contains the milk, and it is allowed to stand undisturbed until the milk has not only acidified, but until it has been formed into a coagulum. When it comes to that state, it is ready to be churned; but it can be allowed to stand over till as much is ready as may be convenient to churn at the same time, and the milk is in no way injured by remaining in coagulum for several days, provided that it is not disturbed, or the coagulum broken; but if that be done before churning can be commenced, the serum separates from the caseous and oily parts, and the whole mass ferments.

When the churning is commenced, the milk that has not soured and coagulated is not churned. If any milk not perfectly coagulated were to be churned with the other, the butter would not be injured by that milk, but fermentation would soon afterwards take place in the buttermilk, and rancidity be produced. But when the whole of the milk has coagulated before churning has commenced, and the operation properly conducted, the buttermilk will have a mild and pleasant acid taste, and the caseous parts will not separate from the serum for many days. The butter produced in this manner will be little inferior to that made from cream alone; but if the cream has been several days in collecting, and been allowed to throw off its serum, or stand long exposed to the atmosphere before it is churned, the butter from it, however oily, will be deficient in flavour, and of inferior quality.

Milk is usually churned in an upright or plunge churn, of a size to suit the magnitude of the dairy. After the milk has been put into the churn, and agitated for a few minutes, merely to break the coagulum of the milk, as much hot water is poured into the churn as will raise the temperature of the milk to 70° or 75°; one person agitating the milk while another pours in the water. The temperature of milk must be raised to or above 70°, before the butter can be separated from the milk; and the temperature of the milk cannot be so well raised in any other way as by pouring in boiling water among it after the process of churning has commenced.

In ascertaining the temperature of milk, both in the dairy and at the time of churning, a thermometer should be used, as indicating it with the utmost degree of accuracy. In general, however, this is ascertained by the peculiar appearance of the milk and other signs which custom and observation have rendered familiar. If the milk is too cool when churning, it swells, has a pale white colour, throws up to the surface many air-bubbles, and emits a rattling noise. But when the milk is raised to the proper temperature, it does not swell, it has a rich cream colour, has a softer sound when agitated, and does not throw up bubbles so plentifully. These appearances, no doubt, assist the experienced dairy people in regulating the temperature of milk under the operation of churning; but a greater degree of accuracy would be attained by using the thermometer.

The operation of churning should be performed with regularity in the motion, and should not be too hastily executed. When milk is overheated, and the churning performed in too short a time, the butter is soft, of a white colour, and of inferior quality. When milk is at the proper temperature, about two hours will be the proper time of churning. The produce in butter, when the milk is of ordinary quality, will be in the proportion of an ounce of butter for every pint of milk; and from the water occasionally thrown into the churn at the time of churning, the quantity of buttermilk will be equal to that of the milk churned.

But frequently the cream alone is churned, being previously separated from the milk and serum. When this method is followed, the milk, when drawn from the cow, is placed in shallow vessels, not more than five or six inches deep, and is allowed to stand in the dairy at a temperature of 50° or 55°, till the cream rises to the surface. In these it remains from twenty-four to thirty-six hours, the cream being repeatedly skimmed off as it rises to the top, and put into another vessel. The cream is removed by means of a skim-dish, with holes pierced in the bottom to allow any portions of milk that might also have been taken up to escape. The first cream that rises to the surface is always richer, and yields better butter than that which is longer in coming to the surface; and on this account, when butter of a very superior quality is desired, the cream first skimmed off only is used, that taken off afterwards being put by itself for butter of an inferior description.

Repeated additions are made to the stock of cream as it can be procured; and it is necessary that it should be frequently stirred to prevent fermentation from taking place, which would materially injure both the butter and buttermilk. The vessel in which the cream is collected may have a cock and spiggot near the bottom, for drawing off, from time to time, any thin serous part of the milk that may be there generated; for, should this be allowed to remain, it acts powerfully upon the cream, and greatly diminishes the richness and quality of the butter. The cream soon acidifies, and the oily matter, with some portion of the milk in the cream, is formed into a clotted state over the serum. The operation of churning should then be performed to prevent fermentation from taking place.

Cream thus separated from milk is an oily substance. When taken off the milk, it still contains a portion of milk, which is separated by percussion or churning. When new, cream forms a rich and delicious food, either alone or in various combinations; but its most common destination is for the production of butter.

The churning of cream should not be hastily performed. An hour is the shortest period in which it can be done with safety, but it need not be protracted longer than an hour and a half; and the operation should be carried on steadily from its commencement to its termination. The best temperature of the cream for the separation of the butter appears to be about 65°, and in cold weather it may be raised to that temperature, or somewhat higher, by the addition of boiling water.

The butter is now removed from the buttermilk, and well washed in, at least, three or four changes of clean spring water, as cold as it can be procured. If the butter is very soft, and the weather hot, it should be allowed to lie for ten minutes or so in the cold water, to harden before it is much beaten. But when that is done, or the butter is not too soft, it must be carefully kneaded with a wooden spatula, or the hand, among the changes of water, till every particle of the buttermilk is expelled. While the butter is yet soft, it is to be salted, the salt minutely mixed, and the butter carefully packed into vessels or casks.

The quantity of salt for butter that is not to be eaten for several months after salting, should not be less than half an ounce of salt, mixed with two drachms of sugar, and two drachms of nitre, to a pound of butter. The sugar improves the taste, and the nitre gives the butter a better colour, while both of them act with the salt in preserving the butter from rancidity. If the salt is not minutely mixed into the butter, it will cause it to be of different shades of colour, and lower its value in the market. But although the butter has to be kneaded among the water, and the salt well mixed into it, especial care must be taken that no more kneading is given than what is absolutely necessary; for an excess of kneading will make it tough and gluey, and greatly injure its quality.

As butter, in its purest state, still contains a portion of the milk and serum, it should not be much exposed to the air, from which it soon attracts a rancid taste; that, however, may be partially removed by kneading in pure water, mixed with a portion of alcohol, but never entirely remedied. When butter is made from rich, well-flavoured milk or cream, and every thing connected with the manufacture of it properly conducted, it has little smell, a mild agreeable taste, and forms a pleasant and wholesome food. When completely divested of impurities, it possesses the properties of oil. It begins to melt at the temperature of 96°, when the pure oil floats over the remains of the milk or other impurities; and this process of purification requires to be performed before it can be carried to a warm climate.

The qualities and flavour of butter are influenced by the cattle from which the milk is drawn, still more by the food which they eat, and, most of all, by the manner in which the butter is manufactured. Some breeds of cattle, and individual cows of every breed, give richer milk than others. Cows that are too young, or too old, and those that are unhealthy, or lean, never yield good milk. When fed on old pasture, or when they are fed on grain or green food during winter, they give richer milk, and more copiously after calving, than when stinted in their food. When fed on turnips, cabbages, clover, and sown grasses, the cows, if in good condition, yield copious supplies of milk; but the butter, in this case, is not of so good a quality, as when they are fed on old though inferior pasture.

The preparation of cheese remains to be described. It consists of the caseous matter united to a certain portion of the oily matter, the quality of the cheese depending upon the proportion of the latter. Cheese is accordingly sometimes made from cream alone, and it is also often made from milk off which the cream has been removed, in which case it is termed skimmed-milk cheese. It may even be made from buttermilk, in which the caseous matter remains, but then it is deficient in flavour and quality; and when it is wished to make good cheese, full milk, as it is termed, should be employed, that is, milk off which the cream has not been removed.

It is desirable that as much milk should be produced at a milking as will make a cheese, in which case it is put into a large vessel immediately after being taken from the cow, being previously strained, and while it is yet warm a table spoonful of rennet is to be added to it, which causes coagulation to take place. The temperature at this period should be nearly that of animal heat or 90°, and if the milk should have cooled it is to be raised to that temperature by the addition of boiling water. When a sufficient quantity is not obtained at one milking, then an additional quantity must be heated to be added to it. In this case the cream will be skimmed off the milk before being heated, and when the two portions of milk are put together, the cream taken off is to be added to the whole; the object in removing it having been to prevent its being converted into oil, in which state some of its particles would be carried off with the whey.

When the coagulation has taken place, the curd is broken or cut with a cheese-knife, which causes the whey to rise through the incisions, and the curd sinks with more ease. After some time the cutting is repeated, and continued until the curd is reduced to small uniform particles, after which the whey is lifted out in flat dishes, the curd, at the same time, undergoing a gentle pressure. The curd is then cut into small pieces, and put into a sieve or vat with holes, and there repeatedly cut, pressed by the hand, and broken, until it ceases to give off any serous matter. A lid closely fitting the vat, on which a weight of forty or fifty pounds is placed, will assist in expelling an additional portion of the whey. As the curd consolidates by this pressure, it is necessary to turn it up twice or thrice, at a quarter of an hour between each turning, and cut it as before, still renewing the pressure until the whey is expelled. The curd is then cut into very small pieces with the cheese-knife, and mixed carefully with salt, after which it is placed in the cheese-vat, with a piece of thin canvass around it, and subjected to pressure. After the cheese has remained under pressure for three hours or so, it is turned out, a dry cloth put round it, and again put under pressure, being usually reversed in the vat. It may then be taken out every five or six hours, and the cloth changed; and this is repeated until the cheese is completely formed, which will generally be in two or three days.

When the cheeses are taken from the press, they are exposed for three or four days to a moderate heat, and turned over twice or thrice in the day, till they harden a little, after which they are removed to the store-room, and turned every second or third day. They are to be placed on wooden shelves, and exposed to a moderate supply of fresh air, which should neither be damp nor very dry, observing to guard them from the direct rays of the sun. The usual produce, when the process has been properly conducted, is a pound of cheese to every three quarts of milk.

In the manufacture of skimmed-milk cheese, the process is not materially different from that described. The milk, instead of being at once coagulated, is put into coolers, there to throw up the cream; and after this is skimmed off, the remainder of the milk is coagulated, subjected to pressure, salted, and formed into cheese. The milk should not be allowed to remain more than twenty-four hours in the coolers; for although a greater quantity of butter may be produced by allowing it to remain longer to throw up all the cream, yet the butter will be of inferior quality, and the cheese will also be materially deteriorated.

Cheese, it has been said, may be made from cream alone; but being in general only wanted for immediate use, it is, in fact, little else than thick sweet cream, dried by being put into a small cheese-vat of about an inch and a half in depth, and perforated with small holes in the bottom, to allow any portion of the milk which may be mixed with it to escape. It must be gently handled and guarded from vicissitudes of temperature; for if once penetrated by frost, or even chilled, much of its mellow richness is lost, and it becomes comparatively insipid; but the extreme of heat must be equally guarded against, or it becomes rank and equally unpalatable. From the difficulty in the mangement, and the expense of the manufacture of cream cheese, it is seldom practised; but when cheese of superior quality is desired, an additional portion of cream may be added to the milk besides that of itself, and on the extra quantity thus added will depend the richness of the cheese.

The rennet in general use is procured from the gastric juice of animals, and particularly from that found in the stomachs of calves. Various other substances, as acids, alcohol, sugar, and the juices of several species of vegetables, will coagulate milk; but as the stomachs of calves form the most abundant and powerful coagulum yet known, scarcely any other is ever used.

When the stomach is removed from the calf, it is examined, and all impurities, such as portions of grass, hay, or other indigested substances, are carefully removed. The curdled milk, however, which is found in the stomach is preserved, being found to strengthen and enrich the rennet; and it will add to the quantity of rennet obtained to feed the animal largely with milk some hours before it is killed. A few handfuls of salt are to be put into the stomach and all around it, and being rolled up, it is hung near a fire to dry; and it is understood to improve by hanging a year or more before it is used.

When rennet is wanted, the dried bag is cut into small pieces, and put into a jar with a handful or two of salt, and a quantity of water that has been boiled and cooled again to about 65°; or new whey taken from the curd is poured on the bag in the jar. The infusion may be allowed to stand for two or three days in the jar, when it is to be drawn off, and a second infusion made, but with a smaller quantity of water, and allowed to remain for two days longer. Both these portions of liquid are mixed, and strained to remove impurities, and put into bottles to be used when required, the cut pieces of the bag being thrown away. The rennet so prepared may be used immediately, or be kept for several months, as may be convenient. Sometimes a small portion of whiskey is added to the infusion. When the rennet has been properly made, a table-spoonful will coagulate a hundred and twenty quarts of milk in ten or fifteen minutes.

In addition to certain qualities being esteemed in butter and cheese, a certain shade of colour is also desired; and several expedients are resorted to, with a view of producing this colour when it is wanting. A certain shade of yellow is connected with the idea of richness in butter; and as winter-made butter is usually pale or white, certain substances are added to impart this colour. Those generally used are the juice of the carrot, and of the flowers of the marigold, carefully expressed and strained through a linen cloth. A small quantity of this juice is diluted with a little cream, and this mixture is added to the rest of the cream in the churn. The quantity of colouring matter which unites with the butter is so small that it does not impart any peculiar flavour. In like manner, it is a frequent practice to colour the milk, so as to give a red tinge to the cheese, which is generally done by a preparation of the red pulp surrounding the seeds of the arnatto tree.

After the curd has been separated, the residuum is whey. From whey butter is sometimes obtained; but it may be assumed, that when any butyraceous matter remains in the whey after the curd has been extracted, the management has been extremely defective. Whey is chiefly employed in the feeding of hogs, to which purpose it is well suited.

These are the principal details connected with the management of the dairy, but the practice even in those districts celebrated for their dairy produce is exceedingly various. This is more especially the case in reference to the manufacture of cheese, and several districts in England have become famous for the production of that article alone. The peculiar flavour of some of these has been supposed to proceed from the superiority of the pastures, but this cannot be regarded as satisfactorily established, imitations being repeatedly produced in other districts which could not be distinguished from the originals. By impregnation the flavour of one cheese is also easily imparted to another.*

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* "If it be required to communicate to a new cheese the flavour and appearance of an old one, it may be done by insertion in the new cheese, of portions of the old one containing blue mould. The little scoop which is used in taking samples of cheese, is a ready means of performing the operation, by interchanging ten or a dozen of the rolls which it extracts, and placing them so as to disseminate the germ of the blue mould all over the cheese.

"A new Stilton cheese, treated in this way, and well covered up from the air for

With respect to the manner of feeding dairy-cows, the most economical, perhaps, is feeding them entirely on green forage during the summer, and on roots in winter. But, as to the effect of food, notwithstanding all that has been said respecting the nutritive properties of peculiar roots and artificial grasses, experience has very decidedly shown that no food is comparable to that of good natural pastures, for milch cows; for not only do they yield a greater quantity of milk when fed on pastures, but the flavour of grass-butter may always be distinguished, by its superior richness and delicacy, from that which has been made from milk produced from soiling in the house. This, however, should not deter the farmer from feeding his dairy stock in that manner, for the difference in the quality of the produce is not so great as to counterbalance the many advantages resulting from soiling. But, in a country like Ireland, where cultivation has not been carried to its fullest extent, and a considerable proportion of the land is necessarily devoted to the production of grass, the cows may be kept advantageously on the pastures during the summer. As in the case of feeding cattle, they must, however, be removed to the houses or sheds before the approach of winter, in which they remain until the grass has become luxuriant in the spring.

Cows should be kept constantly in good condition. When they are suffered to fall off in flesh, particularly in the winter season, it is impossible that they can be brought to yield a large quantity of milk, by getting them into better condition in the snmmer months. When cows are lean at the period of calving, no management afterwards is ever capable of bringing them to afford, for that season, anything near the proportion of milk they would have yielded, if they had been supported in proper condition during the winter. Food of the most nourishing and succulent kinds should, therefore, be regularly given in suitable proportions in the cold, inclement months; and they should be kept tolerably warm, and well supplied with pure water. It will be equally conducive to the health of cows as to that of feeding cattle, to comb them regularly, and to make such other arrangements as are conducive to cleanliness.

In summer, the cows are milked in the field, or they are driven

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a few weeks, becomes thoroughly impregnated with the mould, and generally with a flavour hardly to be distinguished from the old one."—*Prize Essays and Transactions of the Highland Society. New Series*, vol. iii. p. 232.

gently home to their stalls, and milked there. The cows, when in full milk, should be milked three times in the day, and, at other times, twice in the day will suffice. On the physiological principle of the secretions of animals being increased in proportion as the secreted fluid is more frequently withdrawn, the propriety of frequent milkings is apparent, in order to increase or maintain the supply of milk produced by cows. There can be little doubt but that, by accustoming the secretory organs to more frequent action, such a habit may be established in them as will afford a larger proportion of milk in a given time. But, in order to effect this in the most perfect manner, it will be necessary to have the cows highly fed, to observe the greatest regularity and exactness in the hours of milking, and to be careful that every drop of milk is drawn away each time. If any milk is allowed to remain in the udder after the operation of milking, it is well ascertained that the cow will yield a smaller quantity at the next milking; a fact which has been accounted for by supposing that the portion left in the udder is absorbed again into the system, and that nature generates no more than is sufficient to supply the waste drawn away.

A milch cow is usually considered in her prime at five years old, and will generally continue in a good milking state until ten years old, or upwards; but this depends much on the constitution of the animal, some cows, like other animals, exhibiting symptoms of old age sooner than others.

The value of milk and the proportion of either butter or cheese that it produces depend much upon its quality. As the milk of some cows is so greatly superior to that of others, where regularity is observed, it is important that the milk of each should be placed by itself until its quality is ascertained. This is effected by churning it separately; but a more expeditious and convenient method is to ascertain its strength by means of the lactometer, an instrument which should be in every dairy.

XVIII.—SHEEP.

I.—SPECIES AND VARIETIES.

The sheep is an inhabitant of every part of the globe, from Iceland to the torrid zone; and the varieties of form and clothing necessary to fit him for existing in such diversity of climate are numerous. Domestication, or, at least, a long-continued subservience to the human race, and a change of climate and locality, have been productive of several remarkable alterations in the external characters and general aspect of the sheep, as in the case of other animals. Although the sheep and the goat are usually regarded by naturalists as being not only specifically but generically distinguished, the latter, or generic distinction, is believed to be founded chiefly upon characters which have arisen in consequence of the power and influence of man. In a state of nature, the sheep is not less active or energetic than the goat, his dimensions are fully greater, and his muscular strength is at least equal, both in force and duration. He is also an alpine animal, fearless of crag and cliff, and dwelling, indeed, by preference, among the steepest and most inaccessible summits of lofty mountains. Among his native fastnesses he is seen to bound from rock to rock with inconceivable swiftness and agility.

But the most remarkable change which domestication has produced on sheep is the conversion, as it is usually called, of hair into wool, or to speak more properly, the prodigious development of one of the constituent portions of the coat, and the decrease or disappearance of the other. All animals inhabiting a cool or temperate climate seem supplied with both a woolly and a hairy covering; the former being usually short and close, and entirely concealed by the latter, on the length, colour and texture of which the external appearance of the species in a great measure depends. These two kinds of covering are very observable in bears and wolves, and also in the different and more peaceful races of wild sheep; and nothing like either a metamorphosis or new creation is necessary to produce the remarkable alteration in the domestic breeds.

The milk of the sheep yields but little cream, and produces butter of a quality greatly inferior to that of the cow; but the quantity of caseous matter which it contains is comparatively large. It is thicker than that of the cow, and its taste is strong, and not very agreeable. The cheese made from it is rich, and, though of a peculiar flavour, is by many highly esteemed.

Various wild races of the sheep, not as yet, however, in every instance clearly distinguished from each other, inhabit the elevated regions of the different parts of the globe. Its geographical distribution is therefore very extensive, but from which of the wild races the domestic breeds have sprung does not seem to be well ascertained.

The sheep is of the genus *Ovis*, of which there are usually reckoned four wild species:

1. Ovis musimon—The musmon or mouflon of the Mediterranean Islands.
2. Ovis ammon—The argali of Siberia.
3. Ovis tragelaphus—The bearded sheep of Africa.
4. Ovis montana—The Rocky Mountain sheep of America.

These four species differ greatly, in the first place, in their geographical position; and, in the second place, in several of their external characters; though these latter have not yet been detailed with sufficient fulness and precision to enable us to say whether each differs specifically from the other, or is rather its natural representative under a change or modification of climatic influence. Be this as it may, it is certain that from one or other of these unsubdued tribes our domestic sheep has been originally derived.

The domestic sheep of Europe is usually termed *Ovis aries*. It differs essentially from any of the wild races. In the greater proportion of the domestic varieties, the lengthened limbs, and comparatively slender, though strong, active, and graceful forms, have disappeared, and been replaced by heavy proportions, and a consequently indolent disposition. The coarse, dry, brittle coating of hair has been succeeded by that woolly substance of which human industry and ingenuity now form such abundant and manifold materials for the various uses of domestic economy, and the personal comforts of the human race. The prodigious development of the wool, and almost entire disappearance of the hair, would, of themselves, have sufficed to effect a complete alteration in the general aspect and physiognomy of the species; and this remarkable change has been produced in part by physical causes, and in part by the agency of man, who, aiding or counteracting, as he best could, the observed tendencies of nature, has contrived to convert a general law of climate to his own advantage.

Cultivation is thus seen to have effected great changes in the character of the domestic sheep, when compared with what is supposed to be the original stock. Combined with the circumstances affecting local situations, it has also produced a great number of varieties, or, as they are more usually termed, *breeds.* These differ in several particulars, but the main distinction consists in the different lengths of the wool, and they are accordingly divided into long-wooled and short-wooled. Of these the best defined only, shall be noticed here.

The long-wooled sheep are of the largest size, and are especially the sheep of the plains. The new Leicester or Dishley breed stands deservedly at the head of the list, and, indeed, for symmetry of shape, early maturity, and attaining to a considerable size, it stands unrivalled. This breed owes its origin to the late Mr. Bakewell of Dishley, in Leicestershire, and hence the name. It is inferior in size and quality of wool to many of the larger varieties, but for early maturity and aptitude to fatten, it has not been surpassed.

Among the other races of long-wooled sheep, the Lincolnshire and Teeswater breeds may be mentioned. The former of these is remarkable for size and weight of fleece, but the mutton is coarse-grained, and the animals long in being brought to maturity. They require the richest soils to fatten them, even at an advanced age; yet the prodigious fleece which they yield, as compared with other breeds, is an inducement with breeders to preserve the race. The Teeswater sheep present a great resemblance to the Lincolns, but their fleece is lighter, and the whole animal smaller, yet what they want in this respect, they possess in producing finer mutton, and arriving earlier at maturity.

Several other varieties of the long-wooled sheep might be enumerated, such as the Devonshire Notts, the Romney Marsh, and the Coltswood, but unless in a few situations these have lost their original character by crossing, and are more or less assimilated to other breeds. It may be remarked of them, as well as of all the long-wooled varieties, that they are destitute of horns.

The short-wooled varieties of sheep are numerous, and are also distinguished generally by smallness of size. They are hardier than the larger sheep, yet, with few exceptions, not sufficiently hardy for the exposed and mountainous districts ; and, being too restless for enclosed arable land, they will, in most cases, very properly give way to the long-woolod sheep.

The Cheviot and South Down are very generally diffused varieties of this class. The former derives its name from the extensive range of hills, of which it is almost the only occupant, and has gradually spread over all the better mountain districts of Scotland, and the North of England. It varies in character according to the situation in which it is placed, and is to be regarded as one of the most valuable of its class. The South Downs are almost exclusively confined to some of the south-eastern counties of England, and on the chalky districts in these counties they are kindly feeders, producing fine wool and excellent mutton. These, as well as the Cheviot, are without horns.

The black faced, or heath sheep, may be said to be peculiarly those of the mountains. They are distinguished by black faces and legs, and large and spirally twisted horns. The female is, however, frequently hornless. The fleece is long, coarse, and shaggy, and extends over the forehead and lower jaw. This is an active and hardy race, and is capable of subsisting in the most exposed situations, producing mutton of excellent quality, though rarely fattened until four years of age, and sometimes five.

This concise account of the chief varieties of the sheep would not perhaps be complete, without noticing the Merino or Spanish breed, which at one period attracted so much attention in this country, that a Society was formed, having for its special object the extension of the breed. It seems, however, to have been losing ground for some time past. The fleece is, indeed, the finest produced by any variety or species of the genus, but the animal is defective in size, form, and quality of flesh, and these qualities are of much more importance to our farmers than the production of fine wool, which is but a secondary object. This variety is almost universal in Spain, and was introduced into England in 1788. A distinguishing feature of the Merino are its spirally twisted horns, which turn to each side of the head. The wool is also in a sort of corkscrew ringlets, and is of a dingy hue.

II.—ANATOMY AND PHYSIOLOGY OF SHEEP.

The general structure of the sheep intimately resembles that of the ox. The sheep, however, like the ox, experiences considerable variation in size, form, and qualities, resulting from the physical and moral agencies to which it becomes exposed under various climates; and, also, as whether fostered by cultivation, or left to the natural operations of nature. These circumstances have operated even on the osseous structure of the animal, as is seen in the peculiar formations of horn so characteristic of some species, and the absence of these organs in others.

The skeleton of the sheep presents an assemblage of bones, which bears a general resemblance to that of the ox in number and direction. As in the case of the ox, the head is naturally surmounted by horns springing from the frontal bones; but in the most approved breeds at present cultivated, these organs are not present. The frontal sinuses are also large and open, and thus liable to the entrance of insects, which, in the sheep, often prove a source of annoyance. The vertebral column and the ribs present a striking similarity to these parts in the ox, and the extremities descend on the same construction.

The visceral and soft parts are but little dissimilar likewise, the number of stomachs being the same, and performing similar functions, the sheep being also a ruminating animal.

The skin of the sheep differs from that of most other animals in some of its functions. Like them, it is, however, composed of the cuticle, the subjacent mucous tissue, and the true skin. It is exceedingly deficient both in the powers of excretion and absorption; or rather there are circumstances connected with it, which materially limit the action of these functions, snd, as it were, confine the office of the integument to the production and support of the fleece. It is surrounded by a peculiar secretion, impenetrable to moisture—the *yolk*, or inspissated perspiration—destined chiefly to preserve the wool in a soft, pliable, and healthy state.

The amount of cutaneous perspiration going forward from the skin of the sheep is comparatively unimportant; and there are, therefore, few diseases that are referrible to any peculiar state of this excretion. On account of the dense covering of wool which surrounds this animal, the expenditure of caloric is also unimportant, compared with that of other animals. Sheep accordingly suffer less than most other animals from being crowded together. An unnatural and dangerous degree of heat is not so soon produced; and, their skin being defended from actual contact by the close covering of wool, infectious diseases are not so readily communicated. It is only when, in the open field, the animal can rub against a gate or post, so as to break through this natural protection, and denude the skin, that cutaneous maladies spread through the flock.

III.—DISEASES OF SHEEP.

The diseases of sheep are numerous, and sometimes of a very formidable character, often baffling all the means of cure which are known to us. The sheep is constitutionally of such a temperament, that a departure from its natural habits is frequently productive of disease. Most, if not the whole, of the diseases incident to sheep, may be traced to climate, food, and treatment. Under circumstances suited to its natural habits, the sheep is generally seen to enjoy uninterrupted health. But a departure from the proper mode of treatment is known soon to act injuriously on the animal's constitution; hence the vast train of fatal diseases which frequently ensue from confining it in too wet situations of pasturage; from giving it too astringent or too laxative food; from its being much disturbed; or, under certain circumstances, from a want of proper exercise.

In treating of the diseases of sheep, the arrangement adhered to in the case of the horse and cattle shall be adopted, commencing with the head, and describing successively those of the trunk or body, and extremities.

Hyatids, or Staggers. This is a formidable disease of sheep, from the difficulty and uncertainty of any method of cure. It is caused by a parasitic animal, a hyatid, which is found in the brain, or between that and the pia-mater, and frequently imbedded in the cerebral substance. Sometimes only one hyatid is present, but occasionally several are found in the brain; and they attain to a considerable size when their growth is uninterrupted. They are first exceedingly small, and do not seem to occasion much uneasiness to the animal; but they continue to increase in size, until they have absorbed the greater part of the matter of the brain, and destroyed the sheep. The hyatid, when distended with fluid, resembles a round sac filled with water; and hence it was long supposed to be water, and the disease, in consequence, termed *water-in-the-head.*

The symptoms of cerebral hyatids are, stupidity, a disposition to sit on the rump, to turn to one side, and to incline the head to the same side while at rest. The eyes glare; and, from oval, the pupils become round. An accurate examination will now usually discover some softness at a particular part of the skull, generally on the contrary side to that on which the animal hangs its head. When no softness of the skull is discernible, the hyatid usually exists in some of the ventricles, and the destruction of the sheep is certain and quick, from the greater disturbance to the functions of the brain; but when it is situated on the surface, it is sometimes many months before it proves fatal; an absorption of the bone taking place as the hyatid increases, which produces the thinness in the skull.

The treatment in this case is very uncertain. The remedy is to reach the hyatid, and to extract it, or, at least, to perforate it in such a manner as to destroy its vitality. This is effected by removing a small portion of the bone with a sharp instrument, after which, the hyatid is to be removed, and the water absorbed by a sponge. The bone is then replaced, and the wound dressed with tar. The hyatid is sometimes reached by a wire thrust up the nostrils, and, however rude the operation may appear, a cure is often thus effected.

This disease is of much less frequent occurrence at present than it was some time past, and in some places it is unknown, while in others it is prevalent to a fearful extent. As improvements in agriculture have advanced, it has diminished in frequency, and may, ere long, cease to be considered as a disease of the valuable animal now subject to it.

Rot is a prevalent and often fatal disease of sheep. It may be termed inflammation of the liver; for, in all cases of rot, a morbid and diseased state of that organ is an invariable accompaniment. During the progress of the disease, a small animal, called a fluke, *Fasciola hepatica,* appears on the parts connected with the liver and the gall-bladder. In consequence of this, the secretion from the liver is increased—at first scarcely vitiated, and the digestive powers are rendered more energetic; but soon the bile flows so abundantly, that it is taken into the system, which soon after becomes deranged. As the disease proceeds, the liver becomes more disorganized, its secretion more vitiated, and even poisonous: and then follows a total derangement of the digestive powers. The flukes increase in number, and gradually extend themselves to the stomach and other parts. The whole system sympathizes—every viscus of the chest and abdomen becomes gradually involved, and the animal exhibits, in the last stages of the disease, a state of general disorganization which scarcely accompanies any other malady.

It does not necessarily follow that sheep tainted with rot, will die of that disease. Many tainted sheep, when properly treated, afterwards become so far sound, as to fatten well, and produce mutton of good colour and flavour. There are, indeed, many instances in which no one, from examination of the mutton, could decide whether or not the animal had ever been infected with rot.

It is believed, that this disease is produced by a peculiar state of the soil and atmosphere. It is chiefly confined to wet seasons, or to the feeding on ground moist and marshy at all seasons. It has reference to the evaporation of water, and to the presence and decomposition of moist vegetable matter. It is rarely or almost never seen on dry or sandy soils, and in dry seasons; and it is rarely wanting on boggy or marshy ground, except when that ground is dried by the heat of the summer's sun, or completely covered by the rains of winter. In a farm, there are certain fields on which no sheep can be turned with impunity, while on other fields of the same farm, sheep are never known to be affected.

The symptoms of rot can scarcely be mistaken. The sheep affected soon becomes emaciated, its eye becomes dull and glassy, a black purging generally takes place, the wool, on being pulled, comes readily away from the skin, the breath becomes fœtid, and the urine small in quantity, and high-coloured. As the disease proceeds, the skin is marked with spots, and the emaciation increases continually, until the animal dies. The disease proceeds with various degrees of rapidity. During the first period of being tainted, the sheep have frequently a strong tendency to feed, and if killed in time, the flesh may not be perceptibly affected.

Sometimes the disease terminates favourably, the inflammatory action going off without destroying the parts. But even in this case, the taint is rarely removed, and years afterwards, when the animal has been fattened and killed, the liver has been found to be diseased, the flukes abounding in great numbers.

If the sheep are in tolerably good condition when they become affected with rot, they should be disposed of to the butcher without delay, and in the early stage of the disease their value will not be diminished. But should this not be the case, they must, in the first place, be removed off the infectious pasture to the driest on the farm. As in all inflammatory diseases, the sheep may be bled, abstracting eight or ten ounces, according to the state of the animal, after which two or three ounces of Epsom salts are to be administered. The effects of common salt have been more fully ascertained as possessing a beneficial agency than those of any other substance. It is, indeed, the only medicine which has uniformly been found advantageous when medicines could have been of any avail.

If hay is given to the animals, it may be sprinkled with a strong solution of salt in water, and they will eat it greedily; or salt may be placed near them in troughs, or on flat stones, and they will eagerly lick it. When disease threatens, they should be allowed as much of it as they will consume; for it is then seen that they are obeying a natural instinct in having recourse to the remedy; and in a wet season, when disease may be apprehended, no one should grudge the trouble of supplying so cheap and simple a precaution.

But, in the case of rot, prevention is better than cure; and, fortunately, a good deal may be effected in this way. The character of the infectious ground should be altered by drainage, and the sheep should be kept upon the driest parts of the farm. Irrigated lands are not found to produce rot while the water is flowing over them; but on this being removed, and evaporation and decomposition of certain substances on the surface taking place, the disease will certainly be produced; hence it is that sheep should never be allowed to touch irrigated lands. Draining is, indeed, the chief preventative; and when that operation has been thoroughly performed, it may be asserted that rot will seldom make its appearance. Wet seasons may, however, tend to the production of the disease, even on dry ground, and, in this case, the animals are to be plentifully supplied with salt.

Acute Dropsy or Red Water. The inflammatory diseases of the sheep are numerous, and often prove fatal. Among them may be classed acute dropsy, or inflammation of the enveloping membrane of the intestines. It proceeds from the animal being confined on cold damp grounds, which, when the sheep is lying, so chill the peritoneal coat of the intestines, that acute inflammation soon follows. The natural function of the parts attacked, that of secreting a fluid to lubricate the cavity of the belly, is morbidly and strangely increased —the fluid accumulates, and is red and bloody, from the rupture of the small vessels of the peritoneum distended by inflammation. The inflammatory action progresses with almost inconceivable rapidity, and the animal is soon destroyed.

The progress of this disease cannot, in every case, be discovered by any peculiar appearance in the sheep. In the evening, the sheep may be, to all appearance, in perfect health, and in the morning be found dead. The disease is generally attributed to a change of food, combined with undue exposure to wet and cold. A preventative seems to be to keep the animals in dry and sheltered situations. The cure is seldom attempted, from the rapid and fatal progress of the disease.

Diarrhœa and Dysentery are diseases of sheep as well as of cattle. These diseases are seldom entirely separate; and when diarrhœa is of long continuance it frequently degenerates into dysentery. Diarrhœa is a very common disease among sheep. It often proves fatal to lambs. If they are incautiously exposed to cold, or the milk of the dam is not good, or they are suckled by a foster-mother that had yeaned too long before, a violent purging will suddenly come on, and destroy them in twenty-four hours. In the case of lambs, it is, indeed, almost a necessary accompaniment, or consequence of every change of food, and, almost, of situation; and it is frequently a sanative process; but, if it continues longer than two or three days, and begins to be accompanied by the discharge of mucus, remedial measures must be adopted. The medicines to be used are the same as recommended for diarrhœa in calves, and the proportions are to be an ounce of prepared chalk, half an ounce of catechu, two drachms of powdered ginger, and half a drachm of powdered opium. They may be mixed with half a pint of peppermint water, and administered in doses of one or two table-spoonfuls morning and night.

In the case of the older sheep, diarrhœa usually makes its appearance in the spring, when the new grass is coming forward; but it is not injurious, unless long-continued, when the treatment consists in giving the dose just mentioned, but in larger quantities.

Dysentery has been fully described when treating of it as a disease of cattle, and the nature and symptoms of the disease are the same in sheep. The treatment is also similar. In every case of acute dysentery, and whenever fever is present, bleeding is indispensably requisite; for this is essentially an inflammatory affection, and purging is also necessary to carry off the peccant matter in the intestines. After the action of the physic, astringents are to be employed, and, in this respect, the dose recommended in diarrhœa may be given, but containing an additional quantity of ginger, and a little powdered gentian. Mashes, gruel, and hay should be given, and they will be found beneficial in subduing the disease.

Constipation is a disease of sheep, but it is not of very frequent occurrence. The mode of treatment resembles that practised in the case of the other animals.

Foot-rot. This disease is an inflammation of the foot, followed by the ulceration and destruction of the hoof. Its ravages are almost entirely confined to the more improved breeds, as the deficient exercise which they are disposed to take, and the nature of the grounds on which they are kept, tend to the production of the disease. In the more hardy sorts it is comparatively unknown.

The hoof of animals has been seen to consist of a horny secretion formed for the protection of the foot, and as this secretion is continually going on, a certain degree of exercise is necessary to wear down the superfluous portion thus secreted. The soft pasturage on which the sheep is occasionally kept presents little, if any, of that rough friction to which the feet of the animal is naturally intended to be exposed. The crust, therefore, grows unrestrained until it becomes so deformed as to retain particles of earth and gravel, and these, after a time, reaching the quick, produce such a degree of inflammation as soon destroys the foot. This unnatural growth of horn also frequently cracks and chips off, producing fissures which soon become filled with foreign matters, and inflammation is likewise produced.

In the first stage of the disease there is often found nothing but a little projection of the edge of the crust, which is bent in upon the sole, or the edge of the crust is forced from the sole, and earthy matters are introduced which press upon the sensible substance beneath. A sufficient degree of inflammation to throw off the crust at once is seldom produced; but it separates at different parts, and at each part of separation there is new horn formed; this, although soft and unhealthy, and not capable of sustaining pressure, covers, and to a certain degree protects, the sensible parts beneath. By degrees, from increased and long-continued irritation, the parts are no longer able to secrete even this weak horn, but granulations of proud flesh sprout out, and then the work of destruction proceeds with rapid strides.

The ulceration of the foot in this disease will not long exist without the additional annoyance of the fly. Maggots will multiply on every part of the surface, and burrow in all directions. To this, as may be readily supposed, will be added a great deal of constitutional disturbance. A degree of inflammatory fever is produced. The animal for some time goes about on its knees, but at length the powers of nature fail, and, unless speedily relieved, it soon dies from want, combined with the irritation attending the disease.

Although painful and destructive to the good condition of the animal, foot-rot is not absolutely fatal, except under entire neglect. The foot should be carefully examined, and every portion of loose and detached horn pared off, even though the greater part, or almost the whole of the hoof, be taken away. The horn once separated from the parts beneath will never again unite with them, but become a foreign body, and a source of pain, inflammation, and fungous granulations. These granulations are also to be removed when they appear, and afterwards caustic may be applied. The whole foot must be thoroughly cleaned, whatever may be the trouble and amount of suffering inflicted on the animal by it.

The foot is then to be washed with a solution of chloride of lime, which will remove the fœtor, and tendency to sloughing and mortification which generally accompany rot. The caustic application made use of may be the chloride of antimony, which is to be applied to every denuded part; lightly where the surface has a healthy appearance, and more severely where fungous granulations have been cut off, or where they are appearing to spring up. The foot is to be dressed every day, applying the caustic when it appears to be necessary, and the foot should be bandaged up to prevent the increase of irritation from the original cause.

Scab. This is a cutaneous affection of the sheep, analogous to the mange in other animals, and consists in a permanent and increasing irritation of the skin under the form of a pustular eruption. It is connected with, and propagated by, certain minute insects belonging to the genus *Acarus* which inhabit these pustules. The disease spreads over the animal by means of these animalculæ, and is communicated to the rest of the flock in the same way. As soon as the pustules begin to dry up the Acarus leaves its first habitation, and travels to another part of the skin, into which it burrows, and so extends the disease. While thus travelling, it may easily be conveyed to the skin of another animal, with which the infected one comes into contact, and in this manner the disease is communicated to the whole flock.

The symptoms of this disease can rarely be mistaken. The animal infected betrays the utmost restlessness, and rubs itself against every convenient place. The wool is at length partially torn off, and, on close examination, the skin is found to be red and roughened, and sometimes covered in several places with numerous pustules formed by the acari; and a number of them breaking and running together form small or large patches of crust or *scab;* hence the name of the disease. It is contagious in an eminent degree, and if once introduced into a flock, the farmer may be assured that, unless the tainted sheep are immediately removed, the whole of the flock will become infected. As the infection of a diseased flock may be left behind it upon the hedges and pasture fields, precaution is to be used before a fresh flock is turned into fields where infected sheep had been recently feeding.

The cure of scab evidently lies in the destruction of the insect by which it has been produced, and this is effected by means of some external application to the skin. The most effectual application that can be made is mercurial ointment rubbed down with four or five times its weight of lard. It is rubbed on in streaks from the head to the tail, the wool having been previously divided, so as to admit of the ointment being well rubbed into the skin. Several parallel streaks may be rubbed in, but it is not by any means necessary to rub all over the animal; on the contrary, it is injurious, as too large a quantity of the mercurial preparation would produce salivation and general debility. Besides curing the scab, the ointment is efficacious in destroying lice and ticks, which generally accompany that disease in large numbers, and form a source of much annoyance to the sheep.

The Fly. At certain periods of the year, and especially when the sheep is attacked by disease, the common sheep-maggot often proves a serious annoyance. This is the larvæ of a certain species of flesh-fly, which deposits its eggs on the skin of the sheep. If the animal labours under diarrhœa, the excrement accumulates and putrefies around the tail, and the eggs will first be deposited there, or on any accidental wound. The maggots are scarcely hatched before they begin to burrow under the skin. The sheep, when attacked, manifest a strong sense of suffering. They frequently run about with violence until at length, overpowered and exhausted, they lie down and perish. An application of the spirit of tar will effectually destroy the maggot, and the offensive smell of the tar will prevent the approach of other flies, with a view of depositing their eggs.

IV.—THE REARING AND FEEDING OF SHEEP.

In the practice of sheep-husbandry, different systems are had recourse to, according to the nature and extent of the farms on which they are kept, and the methods of farming that are adopted on them. The treatment of mountain sheep is, of necessity, very different from that of the larger sheep on an arable farm. The farmer is, therefore, to be guided in the course of management which he pursues by the situation in which he is placed.

The ewe is sufficiently matured for breeding when fifteen or eighteen months old. They were not usually employed for that purpose until after the second shearing; but the improvement in the breed which develops so soon a disposition to fatten, and prepares them so much earlier for the market, hastens also the development of the generative powers. The ram may be employed at the same period as the ewe; but, at such an early period, he should not be put to so many ewes as one of more mature age. Forty or fifty ewes will be enough during the first season; but, afterwards, the usual proportion of ewes which may be served by one ram is from seventy to eighty.

The rams and ewes being kept in separate enclosures, the farmer can regulate the period of putting them together, and, consequently, the time of yeaning, by the peculiar circumstances of his farm. An endeavour should be made to have the young lambs brought forth at a time when there will be a sufficient supply of food for the dam, to enable her to yield a copious supply of milk, and also for the lambs as they advance in growth. The usual period is from the middle of October to the beginning of November, in which case the ewes will begin to lamb soon after the beginning of March. No preparation is necessary, except, for a few weeks before, to place the ewes on somewhat better pasture than usual; and for this purpose they may be turned upon the stubbles where the young grass is, for a fortnight or three weeks previously. In order to show what females have been impregnated, it is usual to smear the breast of the ram with pigment, which appears on the fleeces of such ewes as he has covered. The ewes which have not received the ram may be taken from amongst the breeding stock, and fed for the butcher.

The period of lambing having commenced, the attendant should carefully observe every ewe that appears to be in labour. While she walks about, and does not exhibit any extraordinary degree of suffering, he should not interfere; nor should he do so if she rises when he approaches, and walks away, unless her labour has been long protracted. He should not be in haste to render his assistance, although she should be continually lying down and getting up again; but if her strength appears to be declining, immediate assistance is required. If she is to be driven to the fold, it should be as gently as possible; and it is better that some others should be driven along with her, in order that she may not be frightened by being alone selected. The early interference of the assistant is always prejudicial, and generally fatal. Nature will, in the course of twenty or twenty-four hours, in the majority of cases, accomplish that which cannot be hurried on by art without extreme danger.

Before assistance is given, it is first necessary to ascertain that the fœtus is coming in a proper position, which is with the head crouched between the fore-legs. False presentations are not numerous in the ewe, but they sometimes occur; and in this case the fœtus must be turned to the proper position. In the case of twin lambs, they may be both advancing at the same time, and then that one which is least advanced must be put back, and the extraction of the other assisted. When it is ascertained that the fœtus is dead, no time should be lost in rendering that assistance which may be necessary to extract it.

The keep of sheep after lambing, when rich pastures or other kinds of grass-lands cannot be reserved, should consist of turnips or other kinds of green food provided for the purpose. The ewes also demand at this time much care and attention, to see that they have a dry, sheltered pasture, free from disturbance, and that neither they nor their lambs sustain injury from too great severity of the season. Whenever this is the case, they should be removed to a situation in which they will have a proper degree of warmth and shelter. High feeding is not found to be beneficial to the sheep during the period of pregnancy, being found to increase the difficulty of parturition; but it is essential after the young are produced, in order that they may be supplied with a sufficient allowance of milk.

The male lambs which are not intended for rams, are to be castrated when they are ten days or a fortnight old. The operation is often delayed long after this period; but it is better that it be performed early. In all cases the lambs should be in perfect health when the operation is performed, and fine weather should be selected for the purpose. An incision is made into the scrotum on each side, through which the testicles are successively protruded, and they are taken away by severing the spermatic cord. Warm weather is very inimical to the success of this operation.

The period of weaning the lambs differs materially according to the locality of the farm, and the quality of the pasture. In a mountainous situation, and where the land is of an inferior description, the weaning often takes place when the lambs are not more than three months old; for it requires all the intermediate time to the beginning of winter to bring the ewes either ready for the ram or fatted for the market. The time of weaning is generally from the beginning to the middle of July, and it is performed by simply separating the lambs from the ewes. They are to be placed as far from each other as circumstances will permit, so that they may not be annoyed by their mutual bleatings, which would prevent them from feeding, and make it difficult to confine them within their enclosures.

The lambs being prevented from drawing away the milk which continues to be secreted, the udders would soon become distended, and perhaps inflamed. It will, therefore, be necessary to take away a portion of their milk at intervals as the udder becomes distended, and thus put them dry by degrees.

After being weaned, the lambs are distinguished by various names, according to sex and locality. They usually receive the name of hoggets, or hogs, the rams being termed tup-hogs, the castrated males wether-hogs, and the ewes ewe-hogs.

It is important that the lambs be put into a good pasture after being separated from the ewes, to make up for the loss of the milk of the dam. They remain on the pasture during the summer, and when the grass begins to fail they are to be supplied with turnips plentifully, which, with hay, is to be their food during the winter.

In the practice of feeding sheep on turnips, the crop may be taken up as consumed, and conveyed to a grass-field for the sheep, and so far as the health and improvement of the animals are concerned this is a good plan of feeding. Turnips, however, are frequently consumed on the land where they grew, and in this case, a portion of the crop is generally removed for other purposes. More than half the crop is seldom consumed on the land, unless it be a very inferior one. The animals are confined to a certain extent of ground by means of wooden hurdles or netling, and when they have consumed the crop within the space thus enclosed, the temporary fence is placed so as to enclose another portion of ground. When nets are employed for this purpose they are supported by stakes driven into the ground in a straight line along the boundary of the space to be enclosed. The nets are placed between the sheep and the stakes, to resist any outward pressure of the animals against them, and to prevent them from passing between the nets and the stakes. The net is fastened to the top and bottom of the stake, by twisting each top rope round the stake. The lower rope must first be set round the stake. There is a peculiar kind of knot called the shepherd's knot, which keeps the top rope fast, supports the net, and binds the whole fence firmly together.*

In the space thus enclosed the sheep are confined. It is of great importance to the comfort of the animals that they be put on in dry weather, especially until they become accustomed to their new kind of food. The spaces first enclosed should be small, because, in the early part of the season, the leaves are very pungent and laxative, till they have been mollified by the frost. A space of fresh turnips sufficient to supply food for a week, is quite enough at any time. In very hard, frosty weather, no more should be given them than they can eat up clean in a day, otherwise many of the half-eaten turnips that have been frosted, and which are useless to the sheep in that state, will rot in thawing, and they will be altogether lost. The portions of the turnips which the sheep are unable to eat off the ground are raised by a hoe, so that they may be enabled to eat them when taken up.

A rack for hay is placed within the enclosed space, on a part off which the turnips have been eaten. It should be so placed, both in regard to position and situation, as to afford shelter from that quarter from which the most troublesome winds prevail. Wind sheds the wool; and, if it be accompanied by rain or sleet, it blows it upon their skins, keeping them wet and uncomfortable so long as the wet weather continues. Shelter from a windy quarter is therefore essential.

In the spring, young sheep will lose their teeth, particularly those which have been early lambed; and if they are put on some of the harder turnips when their gums are in the tender state of shedding old teeth, and of cutting new ones, they would fall off much in condition, from the difficulty they experience in eating the turnips. In this case the turnip-slicer should be employed; and the cut pieces of turnips are made to fall into a box, from which they are consumed by the sheep, even while the operation of cutting is going forward.

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* "Nets for sheep are made of twine from good hemp. They consist of a piece of netting three inches in the side of the mesh, three feet in height when set, and of varied length from fifty to seventy yards. This netting is threaded upon a cord like wire rope, called the 'top rope,' along each side of it. A net which will set seventy yards in length, and three feet in height, will cost from 12*s.* to 15*s.*, according to the thickness of the twine and cord. Stakes for supporting these nets are best made of the seasoned thinnings of plantations, about three inches in diameter, and are placed at about three paces asunder."—*Quarterly Journal of Agriculture*, vol. iii. p. 394.

Before placing sheep on turnip land it is a usual practice to apply a wash, with a view of destroying ticks or other vermin, which would prove a source of annoyance, and also of removing any latent tendency to cutaneous diseases. This consists of a decoction of tobacco and oil of tar, with the addition of a little soft soap and sulphur. A pound of tobacco, a pint of oil of tar, a pound of soap, and a quarter pound of sulphur, in five gallons of water, will be sufficient for twenty sheep.

The sheep are sometimes, though rarely, liable to accidents while feeding, such as choking from a piece of a turnip, and distention of the rumen from food, and from gas produced by the fermentation of the food. The treatment of these cases does not differ from that described at length when treating of them as accidents occurring to cattle.

The young sheep are, in this manner, fed on turnips and hay until the grass is ready in spring. This will be at an earlier period than cattle could be turned to the pastures, the sheep being a close-biting animal, and being capable of subsisting without inconvenience, where cattle would starve. In the event of the turnips failing before the end of winter, such other nutritious food may be given with the hay as the farm will produce.

The shearing of sheep is an annual operation which requires several preparatory measures. The period at which this operation takes place is usually the end of May or beginning of June, the precise period depending on the state of the animals. Sheep in high condition will be ready for shearing sooner than those in a lean state. The wool at this time comes readily off when plucked, and this is the criterion to be adopted in ascertaining when they should be shorn.

About eight days previous to shearing, the sheep are to be washed, to free the wool from impurities. The washing-pool may be in any part of a stream or rivulet, from two to three feet in depth, and the bottom should be pebbly rather than muddy, which it will naturally be, if a gentle current passes through the pool. If no rivulet near presents these desiderata naturally, a pool must be made by artificial means to answer the purpose. After the pool is constructed, the sheep are brought to one of the banks of the rivulet, so as when they are removed from the water, they may have a grass bank or field to stand upon. Three or four men will be necessary to stand in the water, so arranged that the first man shall be lowest down the stream, in order that the water may be clean when the sheep are finished. A number of hands should be in readiness on the bank to hand the sheep to the persons washing; or a piece of ground may be netted, or hurdled in, to prevent them from wandering, and save time in bringing them to the water. Every thing being thus prepared, a sheep is handed to the first man, which he seizes and pulls into the water, and immediately turns over on its back, holding the arm of the fore-leg with the left hand, and grasping a portion of the wool at the side of the head with his right hand. He is thus enabled to turn the sheep over from side to side, while, at the same time, he pulls it gently backwards and forwards from and to him at every successive turning. In this process, the wool waves up and down in the direction of the length of the body, and swirls round the body, first in one direction and then in another. He then hands the sheep to the next washer, who repeats the same operation, and he to the next, and so on to the last person, who examines the fleece, plunging the sheep at the same time, and thus finishing the process. When ewes having young lambs come to be washed, the lambs are previously separated from them.

By this operation, the body being in an inverted position, the skin and wool of the sheep are cleaned as if they had been washed in soap and water; and, in fact, they have been so washed, for the oil or yolk of wool presents similar chemical components to soap. The surface of the water may be seen covered with greasy matter and filth, which are carried away gradually by the current.

The sheep, being washed, are put into a clean grass field, where they cannot dirty their wool under banks of earth. The fleece will soon dry, after which the sheep may be shorn; but it is better that seven or eight days should elapse between the periods of washing and shearing, as this time is necessary to bring the oil again into the wool, without which the wool should not be shorn, as it loses its peculiar lustre with the loss of the yolk.

When the sheep are to be shorn, they are put into some enclosed space, generally a shed or barn, in which the operation is performed.

A winnow-cloth, or large sheet, should be spread on the floor, and fastened down the corners, and on this the operation is performed, to keep the fleece clean. Every thing being thus arranged, the shearer takes hold of a sheep, which he sets on its rump, and it is kept in that position by resting against his legs. In this position, the wool is removed from the head and neck, and the operator afterwards clips in a circular direction from the belly to the back. The animal is then laid on its side, and kept down by the leg of the shearer, who clips the fleece all round the back. All dirty portions of the wool about the tail and belly ought to be removed by the shears, and kept together by themselves. The outside of the fleece is folded inwards, beginning with the sides, and narrowing the whole fleece into a stripe of about two feet in breadth. This stripe is then rolled firmly up, from the tail end towards the neck, the wool of which is stretched out and twisted into a rope, and wound round the fleece to give it a cylindrical shape. The clippings are steeped in water, and washed by the hand, and afterwards dried in the sun.

In using the shears, they should be held as closely as possible to the body of the animal, with their points a little elevated. Every stroke of the shears should be short and narrow, to make a clean clip. The clips of the shears appear in concentric rings round the body of the sheep. The oil of the wool assists the action of the shears, and they are kept sharp by a whetstone.

Different names are again applied to the sheep after being shorn. They are now shearlings—shearling wethers, shearling ewes, and shearling tups, or rams. But it is also usual to apply other names to them, the wethers being frequently termed dinmonts, and the ewes gimmers.

The ewes, or gimmers, are kept on the pastures during the second season, and such as are intended for breeders, receive the ram at the proper season. The wethers, or dinmonts, are fit for the butcher soon after being shorn.

But it is only in the case of the more improved breeds being reared, and the supply of food of the best description, that the dinmonts are thus disposed of at this early period. More frequently they are kept on the farm for another winter, when the management is the same as during the first year. The dinmonts, however, are frequently sold fat before they have completed the entire winter's feeding, and when not disposed of at this period they are sold after being a second time shorn. It is more profitable, however, to be able to feed off sheep when shearlings, than to retain them till they are two years old, and this can be easily accomplished on every arable farm on which turnips can be cultivated.

The details of the rearing and feeding of sheep on arable farms have now been given at length. But frequently, instead of the animals being produced and fattened on the farm, the operations of the farmer may be either confined to breeding sheep and disposing of them before they become fat, to pass into other hands, before they come to the butcher; or they may be confined to fattening sheep, always purchasing the stock from the breeder. In situations, however, where the breeding and feeding of sheep can be carried on with equal advantage, they may, with economy, be combined on the same farm.

But instead of rearing all the animals to the age of one or two years, the lambs are sometimes disposed of fat during the first summer. In this case they are fattened merely on the milk of their dams. In certain cases, however, the ewes are made to produce the lambs at those seasons which are found to suit the adjacent markets best, and the lambs are fed in the house.

Grass in summer, and turnips and hay in winter, form the chief food of sheep, and they are seldom difficult to procure in favourable situations. In the absence of turnips, however, the different root crops cultivated on the farm may be substituted with advantage. Salt has been mentioned as beneficial in certain cases of disease, but it is equally valuable as a condiment to the animals in perfect health, and should always be supplied to them. When placed within their reach they will eagerly consume it, and after a time they will manifest greater anxiety for their daily supply of salt than for their food.

The management of sheep in mountainous districts differs, in some respects, from that described. Here there is not such an abundant supply of food, nor is that food of such a superior quality; a race of animals different from those cultivated on the arable lands will therefore be necessary, and in these hardiness of constitution will be the most valuable property.

In the case of the mountain sheep, the period of putting the ram to the ewes is somewhat later than in the more improved breeds, in order that the lambs may not be brought forth until the season is advanced, and the herbage well sprung up. Throughout the winter the sheep are kept on the pasture, and during stormy weather they have an allowance of hay, and a few turnips when they can be produced; but hay generally forms the only addition to the spontaneous productions of the pastures. When the lambing season arrives, the same care is necessary on the part of the shepherd or attendant, as has been described, and in general more losses will be sustained at that period on account of the inferior condition of the ewes, and the general debility which is often seen after a severe winter.

The operations of castration, weaning, and shearing, do not differ from those in the case of the more improved breeds.

The operation of smearing may be regarded as peculiar to the mountain races of sheep. This is performed with the view of destroying vermin, and protecting the animals from the inclemency of the weather. It is, however, injurious to the wool, and there is great diversity of opinion regarding its efficacy for the purposes for which it is intended. It no doubt destroys vermin and tends to the prevention of cutaneous diseases. The chief ingredient in the composition is tar, and this is the substance which so much affects the quality of the wool, but it is durable, remaining until the animal is shorn. The usual substances employed are tar and butter in the proportion of a gallon of the former to six pounds of the latter, and this is said to be sufficient for twenty sheep. Combinations of tar with other substances, are also employed, such as oil, soda, and even potatoes boiled and pounded, the effect of which is to render the tar more easy of separation from the wool.

Whatever composition is employed it is important that it should be rubbed in streaks on the skin, without daubing the wool, as the heat of the skin increases its fluidity. The usual time for performing the operation is during the early part of the month of November, just before the severity of the winter sets in.

Vast numbers of sheep are reared on the more elevated and mountainous districts of the country, and it is fortunate that an animal exists so well calculated for these unfavourable situations as the sheep. The flesh of these is much admired on account of its superior quality, but in most cases the animals are fattened in some more favourable situations than those in which they have been produced. They are indeed often reared in the mountains and fattened on the arable lands, but, in the latter situations, some of the more improved breeds would make a much greater return. In the case of the mountain breeds, the animals are sometimes four years old before they are disposed of to the butcher.

The sheep being an animal subject to numerous diseases, much care and circumspection are necessary in the purchasing of these animals, and this is more especially necessary when any part of the stock purchased is intended for breeding. A sheep may be labouring under incipient disease without much perceptible appearance of suffering; but there are certain appearances characteristic of health, and these should be minutely observed.

The appearances which show the sheep to be in a proper sound state of health, are, a rather wild or lively briskness; a brilliant clearness in the eye; a florid, ruddy colour on the inside of the eyelids, nostrils, and gums; a fastness in the teeth; a sweet fragrance in the breath; a dryness of the nose and eyes; the breathing easy and regular; coolness in the feet; dung properly formed; coat or fleece firmly attached to the skin, and unbroken; and the skin exhibiting a florid red appearance. When there is a discharge from the nose or eyes it indicates their having taken cold, and should be attended to by putting them in dry and warm situations.

XIX.—SWINE.

I.—VARIETIES.

The different species and varieties of the genus *Sus*, to which the common domestic hog belongs, are now found in almost every part of the globe. They are extremely prolific, and have accordingly spread over every country into which they have been introduced in a comparatively short space of time. The wild boar, from which our domestic varieties are derived, is found in most parts of Europe, and Asia, and is very different from the domesticated races. His colour is a brownish black all over the body, with bristles hard and stiff, especially along the spine. He is an animal of great strength, and considerable activity ; but his dimensions, though large, do not equal those of some of the domestic breeds. For the first three years of his life, he follows the sow, the whole litter living in a herd together. This appears to be for the purpose of mutual protection against their enemies, for when attacked, they give each other assistance, the strongest facing the danger. When the boar, however, attains his full size and strength, he ranges the forest alone and unsupported, dreading no single creature, not even man himself. In a state of nature, he is said to live forty or fifty years.

The varieties of the common domestic hog, *Sus Scrofa*, produced by cultivation, are numerous, and differ in several respects strikingly from each other. It will be sufficient, in this place, to notice only a few of the best-defined breeds, which will sufficiently illustrate the differences of size and character in these animals. The most distinguished are the following :

1. The Chinese Hog.
2. The Berkshire Hog.
3. The Irish Hog.

The Chinese hog is distinguished by the upper part of its body being almost bare, and its belly hanging nearly to the ground. Its legs are very short, and its tail still more disproportionably short. It varies in colour, being sometimes black, sometimes white, sometimes irregularly patched with black and white, frequently of a dark grey, and occasionally of a sandy hue. The breed, as its name imports, came originally from China, where it still abounds; and a similar race is supposed to be diffused over New Guinea and the islands of the South Sea.

Though the form of the Chinese hog is good, and its flesh excellent, persons of delicate taste are apt to think that it fattens somewhat too early. It has, however, been a great and undoubted medium of improvement of the several races of this animal in the United Kingdom. By a mixture of the Chinese black swine with those of the larger native breeds, a kind has been produced possessing qualities superior to those of either of the parent stock. They are extremely prolific, are sooner fattened than the larger kinds upon a less quantity of food, and they cut, when killed, to more useful and convenient portions.

The finest of the Chinese breed are remarkable for the delicacy of their appearance, for their thin, transparent ears, their small heads, and short and slender legs. They are perhaps too small for bacon, but for roasting and producing the most delicate pork they stand unrivalled. The larger sorts of this breed weigh ten or twelve stones when about a year old, and they may be recommended as being suitable for arable farms, and for general cultivation.

The Berkshire breed is very generally diffused throughout England and Scotland, and was one of the first improved breeds. Berkshire has been long famous for its improved and valuable breed of swine, which has gradually spread over the island. It is, in general, of a reddish colour, with black spots, large ears hanging over the eyes, short legs, small bones, and well inclined to fatten. The bacon produced by this breed is of a very superior quality, and the animals attain to a great size, often weighing from forty to fifty stones, and in some instances animals of the Berkshire breed have attained the great weight of a hundred stones.

The old Irish hog is now rarely met with, even in the most remote districts, a more valuable sort having, in most instances, occupied its place. This breed is of a large size and coarse form, producing bacon of a quality very inferior to any of the more improved breeds of the country. It is generally of slow growth, and requires a comparatively long period to fatten. It was at one time very generally diffused throughout Ireland, but within the space of a few years a great improvement has taken place in consequence of the introduction of some of the more valuable breeds, and the crosses of these with the native Irish.

Like the other domestic animals, a great number of varieties and sub-varieties of the hog have been produced by cultivation and climate. Crossing has also been the means of extending the number of varieties, which are distinguished by the names of the particular districts in which they are produced.

II.—ANATOMY AND PHYSIOLOGY OF SWINE.

The hog, physiologically considered, differs in many essential points from the horse, the ox, or the sheep. The fat of the hog differs from that of almost every other quadruped, not only in its consistence and quality, but in the mode of its distribution over the body of the animal. The fat of those animals which have no suet is pretty equally mixed with the flesh; in those animals which have suet it is found only at the extremities of the flesh; but the fat of the hog is neither mixed with the flesh, nor collected at its extremities, but covers the animal all over, and forms a thick, distinct, and continued layer between the flesh and the skin. In this respect it may be said to resemble the whale and other cetaceous animals.

The fecundity of swine is remarkable, and, in this respect, they form an exception to two general, and, except in this particular instance, perhaps universal, laws of nature. Digitated quadrupeds generally produce the most numerous progeny, and, throughout the whole circle of animated nature, the largest animals are generally the least prolific; but to both these general laws the hog forms a remarkable exception.

The bony skeleton of the hog has considerable resemblance to that of the other domestic animals, but differs materially in the number of the bones, and, also, in some cases, in their peculiar conformation. The viscera of the trunk or body more nearly resembles that of the horse than of either the cow or the sheep; the hog, like the horse, having only one stomach, and not being, therefore, a ruminating animal. The venous and arterial system of the hog is more deeply seated, and, perhaps, less fully developed than in the case of any of the other domestic animals.

III.—DISEASES OF SWINE.

The adage, that prevention is better than cure, is more especially applicable in the case of swine than of the other domestic animals. From the great importance which is now attached to the veterinary science by the landed interest, the diseases of horses, cattle, and sheep have been investigated with the most patient research, and such a knowledge of their nature and treatment has been obtained, as amply to reward the labours of those engaged in the study. The diseases of swine, however, have not been investigated with the same research and assiduity, and little is accordingly known of their nature and treatment. This arises, in a great measure, from the peculiarity of structure which has just been noticed, and also partly from the circumstances of these animals being considered as a subordinate species of live-stock, and unworthy of the same minute attention which has been paid to the others. But it is fortunate that the maladies to which they are subject are not numerous, and, under proper management, a diseased condition rarely occurs.

When food is supplied to swine in unlimited quantities, they occasionally suffer much from indigestion, caused by a surfeit of food being consumed. This occurs more frequently when they are not regularly supplied with food at stated intervals; for when the animals have been kept long without food, they are more liable to suffer from a surfeit, their appetite being then voracious, and seldom satisfied until an undue quantity of food has been consumed. The remedy consists in supplying the animals with food at regular intervals, and observing that an undue quantity is not given at a time.

Swine also suffer, in some cases, from eruptions of the skin, which usually break out first on their ears, and, if not attended to, sometimes spread over the body in cutaneous pustules, occasionally violent itchings, and finally scabs. These arise more frequently from want of proper ventilation and attention to cleanliness in their styes than from any other cause, though they sometimes also occur from the animals being fed too high on heating food, and sometimes from the opposite effect of starvation. On the first appearance of eruptions, small doses of sulphur and nitre mixed with their food will speedily restore the skin to its natural state. When the disease has proceeded to such an extent as to produce ulceration, the parts should be well rubbed with a composition of oil and tar.

The measles frequently attack these animals, but they seldom prove fatal. The commencement of the disease is attended by languor and decline of appetite, followed by small pustules in the throat, together with red and purple eruptions, more distinct after death than during the life of the animal. The disease is generally said to be removed by administering small quantities of the sulphuret of anatomy in the food.

IV.—THE REARING AND FEEDING OF SWINE.

These animals arrive early at maturity. The sow is fit to receive the male when little more than eight months old, and the latter is capable of propagating his species at the same early period; but neither of them should be allowed to be used for the purposes of breeding until they have completed their first year, and the male should be admitted only to a limited number of females for some time after. The period of gestation in the sow is about sixteen weeks. The number of young produced at a birth varies from five to ten or twelve, or sometimes even to eighteen or twenty, and two litters are produced in the year, or even five in two years.* She is ready to receive the male soon after the birth of her young, but the period of impregnation should be regulated by that at which it is desirable the young should be produced. This should rarely take place in the winter season, as the young animals are exceedingly delicate, and thrive slowly in cold weather. When two litters are produced in the season, which is the usual practice where breeding sows are kept, the periods of impregnation should be about the beginning of October, and the beginning of April, as the young will then be produced in February and August, so that the last litter will have gained full strength before the approach of winter.

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* Some curious calculations have been made to show the extraordinary prolificacy of these animals. The celebrated Vauban formed a calculation to show the probable production of an ordinary sow during the space of ten years, and in it he did not comprehend the male pigs, though these may reasonably be presumed to be equally numerous with the females. The average number produced he estimated at six pigs to each litter, which is certainly low enough, and the result he obtained for the product of a single sow in eleven years, which are equivalent to ten generations, was the astonishing number of 6,434,838 pigs. He further observes, that were the calculations extended to the twelfth generation, the result would have been as great a number as all Europe would be capable of supporting; and, extended to the sixteenth generation, it would abundantly people the globe.—*Quarterly Journal of Agriculture*, vol. iii. p. 37.

The pregnant sow should be separated from the herd, but it is better that she be allowed a certain portion of the yard for walking about and exercise than entirely confined. The period of bringing forth will be generally indicated by the animal carrying straw in her mouth to make her bed some time previous, and she must then be well littered with short straw; for, when profusely littered with long straw, the young pigs are liable to be injured or killed by the mother while they are nestling under the straw unperceived. The young animals, being extremely tender, are liable to be destroyed immediately after their birth by the motions of the dam; and to guard against this, they should be attentively watched at this period, and the young ones removed from her as they are brought forth. In some instances, the sow would destroy her own young if unrestrained; and, in all cases when any of the other grown stock are admitted at this period, they generally manifest their carnivorous propensity by destroying and consuming the young pigs.

During the first and second day after the birth of the young, or until they acquire strength, they should be removed from the dam, and only occasionally admitted to suck. While nursing, she should be well fed, and the pigs accustomed to feed from a trough on milk, whey, or any liquid food, mixed with a little meal or bran. The males may be castrated when about a month old, and a like operation, though not absolutely necessary, may be performed at the same age, on such of the females as are not intended for breeding.

The period of weaning is regulated by the manner in which the young pigs have been fed; and, when they have been liberally supplied with food, it need not be deferred longer than six or seven weeks; for when the period of weaning is delayed long after this, the sow will be in low condition as the time of bringing forth her young again approaches. When weaned, the young pigs should be fed three times a day on nutritious, and chiefly farinaceous food, combined with milk or whey; and, in a few weeks, they will consume the ordinary roots cultivated upon the farm. In some instances, the young pigs are disposed of while they are sucking, especially when the number brought forth is greater than the dam can perfectly support; and, when intended for being killed, they are then termed porkers, or roasters.

The young pigs, after being weaned, are sometimes allowed to go at large through the pastures, and have to depend on these chiefly for their food. In this case, they do great injury to the fields, by digging up and otherwise destroying the surface; and although this is prevented, in a great degree, by slitting the cartilage in front of the nose, with which they turn up the soil, yet they still effect more or less injury to the pastures, and the fences of the fields in which they are confined. The more approved practice is to confine them in their pens or styes, allowing them occasionally to go through the feeding yard, to pick up any refuse of the food of other animals scattered through it; and, in addition to this, they are supplied with a little green food, as tares or clover during summer, and turnips or potatoes during winter. In this manner, they are supported in tolerably good condition at very little expense, until the period for fattening them off for the butcher arrives, when they are to be supplied with better food.

The food of swine, whether with a view to growing or fattening, is, of course, regulated in a great measure by the situation and circumstances of the farm. The cottager's pig must be contented with the scanty offals of his kitchen and dairy, the produce generally of a single cow. Towards the end of autumn, a few potatoes are added for the purpose of preparing it for slaughter, and perhaps a little meal is mixed with boiled or steamed potatoes for a week or two before. Such pigs, however, often thrive amazingly, make themselves moderately fat, and form a most valuable addition to the winter stores of their owners. But, on farms of greater extent, a sufficient supply of food can be raised, and they are abundantly supplied with green food, in addition to the offal of the farm-yard.

The food of swine may be of a more varied character than that of any other animal. Every kind of animal refuse, as that of the dairy and kitchen, is eagerly consumed by them, and in every case forms a portion of their food. Roots of the different kinds cultivated on the farm are eaten, raw or boiled; but the hog, not being a ruminating animal, derives more advantage from boiled or steamed food, especially in the case of roots. All kinds of farinaceous substances, as the seeds of the different kinds, form a nutritious and valuable, though rather expensive food; and brewer's grains, and wash of the distillery, form the best food that can be given to them. They feed on green food of all kinds, such as tares, clover, lucern, and cabbages; and these substances are, accordingly, employed for feeding them in summer, and are well adapted to the purpose, though to fatten them more nutritious food will be required.

It is, however, of importance, that they should be at all times liberally supplied with food, and that too at stated periods. They ought to be fed three times in the day, and the troughs in which the food is placed should be emptied before a fresh supply is given, and washed out occasionally, so as to keep them perfectly clean. Although the hog delights to wallow in the mire during the heat of the day, he prefers a clean and dry bed; and his food should also be supplied in a clean trough. In supplying these animals with food, it is better that it be of a varied kind, such as alterations of liquid and solid food.

The flesh of the hog when fatted may be disposed of in two ways. The one is to yield pork, and the other to produce bacon. When the former of these methods is adopted, which, indeed, is usually the most convenient for the farmer, the animals are fatted at a much earlier age than when intended for bacon. In the former case, the age seldom exceeds six or eight months, and in the latter ten or twelve.

When the substances employed in fattening have been succulent rather than nutritious, the flesh will be much improved by feeding with bran-meal, mixed with the other food, for some time previous to killing the animals. Though advantageous either for pork or bacon, it is more essential when the object is to produce bacon, as it tends to harden the flesh, and render it of that mellow firmness which constitutes the essential property of fine hams and bacon. Some time previous to the period of killing the animal, therefore, the food may consist of about two-thirds of steamed potatoes, or other roots, and one-third of ground pease, barley, oats, or bran, enlarging the quantity of farinaceous food as the animal fattens.

An important department in relation to the management of swine, is the preservation of the flesh after the animals are killed. In the case of pickling pork, the carcass is cut in pieces, and packed up in vessels, containing from one to two hundred weight. A solution of salt in water is prepared strong enough to swim an egg, which is to be boiled, and as soon as it has cooled again, it is poured on the pork, so as to cover it. The vessel is now closed up by fastening in the top, and the pork is ready for market. In this state, it may be preserved for two or three years, and it is said to improve in flavour during that time.

But the more general application of the flesh of the hog, at least that portion consumed on the farm, is for the purpose of bacon. In this case, the hams or legs are separated from the flitches or sides, as close to the latter as possible without injuring their appearance. The body is then separated from the head, and cut longitudinally in the direction of the back-bone, and then transversely between the second and third ribs. The hams and flitches are then laid on boards, sprinkled with saltpetre, and covered with salt, and it is better that the salt be well rubbed in by the hands. They are to be placed afterwards in a cool place, and in this state they lie about a week, after which they should be turned, and an additional quantity of salt sprinkled over them. In about two or three weeks from the period of the first salting, they are hung up in the chimney of the kitchen, or in a smoke-house to dry. The usual practice of preserving bacon and hams on the farm is to dry them in the farmer's kitchen, where the fuel is turf or wood; but, on the large scale, houses are constructed expressly for the purpose.

In Westphalia, and several other places celebrated for the flavour of the hams produced, sugar is commonly employed in curing, in the proportion of about one pound of sugar to three of salt, and two ounces of saltpetre. The sugar assists in preserving the meat, renders its fibre mellow, and corrects the extreme pungency which is often occasioned by the too free use of salt. In every case, after the hams and flitches have remained hanging a sufficient time to dry them, they are taken down, and packed up in seeds from the mill, or saw-dust, in which they remain until they are required for use. The proper period for curing bacon is during the cold months of winter.

The rearing and fattening of swine form an important part of the labours of the farm, and the animals are known to make a more profitable return for the quantity of food consumed, than any of the other live-stock. The flesh forms a chief part of the animal food of the labouring classes, and is nutritive and well calculated for such as are engaged in active labour. From its ready reception of salt, it is better calculated for long preservation than that of any other animal. It is, however, doubted by many competent judges, whether swine form a profitable stock, when supported on food requiring to be raised especially for that purpose. Their chief advantage consists in their being nourished by what would otherwise either prove nearly useless, or be entirely lost. A certain number can, at all times, be kept on the farm, and fed on the various kinds of refuse; and in the case of the cottager, the animal is invaluable, thriving abundantly on the refuse of his kitchen, and making a profitable return for what otherwise would go to waste.

XX.—CAPITAL REQUIRED IN FARMING.

The importance of capital in every branch of industry is universally acknowledged, and in none is it more requisite than in farming. When there is any deficiency in that important particular, the farmer cannot derive an adequate profit from his exertions, as he would necessarily be frequently obliged to dispose of his crops at an improper season to procure ready money; and it would restrain him from making advantageous purchases, even when the most favourable opportunities occurred.

The amount of capital which it is necessary that the farmer should possess partly depends on the customary degree of credit in the country. The farmer does not usually pay ready money for all the commodities he requires, but trusts to that degree of credit which is common in his business. And the same remark applies to almost every class of traders in this country. A merchant rarely limits his trade to the extent of his ready money, but trusts to that degree of confidence which exists; and, in this way, much of the trade of the country is carried on. In like manner, the farmer may not find it necessary to possess all the capital which would be required were he to pay for every thing; yet the nearer his funds approach to this condition, the greater will be his security. Too many engage in extensive farming on a loose and imperfect estimate of the funds required, and find, when too late, that they have miscalculated their means. While, therefore, it cannot be contended that a farmer, who lives in a country where credit is the soul of commerce, is not to avail himself of this benefit, yet he must be careful not to miscalculate its effects; and at all events, and like every prudent man, he must make himself acquainted with the real amount of his pecuniary obligations. This is the true principle on which the capital required for the farm should be computed. The sum to be determined is that which the farmer has to advance, before a quantity of produce is raised upon the farm sufficient to replace the advance, and supposing all payments to be in money.*

But the amount of necessary advances differs greatly according to the nature of the farm, the mode of management to be pursued upon it, the period of entry and the time of paying rents, the manner of paying labourers, and a multitude of circumstances dependent on local practice. So various are the soils and situations of farms, that one system of husbandry is inapplicable to all. There are arable farms and pastoral farms; the former requiring a quantity of live-stock chiefly for labour, and the latter a still greater number of live-stock, but chiefly for feeding and breeding. But the state of a wholly arable farm, and that of a wholly pastoral one, are so widely different, that there are few circumstances which are common to both, and upon which could be constructed a formula by which a calculation may be formed of the amount of their respective capitals. This would pre-suppose a mathematical precision to which no matter of husbandry is perhaps entitled. After all, however, the instances adduced are extreme ones, and although we cannot employ the terms of a formula to acquire what we desire, there is such a precision attending the subject as will warrant us in forming a common standard to which every other instance of the kind may be referred.

We have already seen that there is a fixed rotation of cropping to be practised on every soil, according to its nature, which distributes the various kinds of crops, whether white or green, equally over the farm. These remarks apply to arable farms. But live-stock as well as corn crops are raised upon arable farms. To obtain an equal advantage from the live-stock as from the crops—to unite, as it were, the extremes of an arable and pastoral farm,—the one is intimately blended with the other. The live-stock are reared up on the farm through the assistance of one portion of the series, and this grafting of live-stock upon the alternate system constitutes what is termed the *mixed* system of husbandry.†

Before live-stock can be profitably disposed of, they must remain a certain time upon the farm. This has the effect, in most instances, of extending the series, as to the period of one of the green crops—

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* Elements of Practical Agriculture.

† Quarterly Journal of Agriculture, vol. iii.

the grass—in the alternate system. This extension of the rotation is not found detrimental in any degree; but, on the contrary, it is beneficial to the land, to the live-stock, and to the succeeding grain crop: to the land, in receiving manure for one year more at least from the live-stock; to the live-stock, by the exhibition of the rich feeding pastures in the second year, and subsequent years of the rotation; and to the succeeding crops, in luxuriating in a richer sward, and less exhausted soil. This mixed system is now the most approved one in the agriculture of the United Kingdom.

The circumstances under which land may be occupied being so various, it then becomes necessary, in calculating the amount of capital required in any case, to limit the calculation not only to soil of a particular quality but also to a given extent of land managed in a peculiar manner. In the following calculation, therefore, the assumption is made of a farm suited to the five-course rotation, and on which the mixed system of husbandry is practised; and as it is necessary to fix upon a certain size of farm, in order to ezhibit a determinate value of the stocking required, a farm of 100 acres is selected as being one of medium extent in this country. On a farm of this size, managed according to the rotation mentioned, there will be—

- 20 acres in corn, namely, oats.
- 20 acres in green crop, namely—
  - 16 acres in turnips, beet, and carrots.
  - 3 acres in potatoes.
  - 1 acre in beans.
- 20 acres in corn, sown with clover and grass seeds.
- 20 acres in young grass.
- 20 acres in grass in its second year, for pasture.

In the enumeration of implements and live-stock required for the farm, it will be necessary to attach the price of each, as conveying an idea of the money value. Prices are, it is true, apt to vary; but if those of the present date are taken, they can form a sort of standard to which comparative reference can be made at any future period. It will be necessary to insert the prices of live-stock as if they had been purchased in the public market; and those of the implements as if they had been ordered quite new from the manufacturer; but should any of the articles be purchased at sales of farming stock, allowances must be made according to circumstances. Prices, too, are various in different parts of the kingdom, depending in some degree on the quality of materials and workmanship, but it is conceived that the annexed list will apply to Ireland generally, without any considerable inaccuracy, it being the country to which they have especial reference. To make the calculations applicable to either England or Scotland, more especially the former, a considerable addition to the various items must be made, labour, and the consequent cost of production, being much higher in these countries. The same also holds good in all calculations of the expenditure of the farm.

The period of entry is assumed to be on the 1st of November, as being the usual period of entering upon the occupancy of land in this country. Whitsunday is the general period of entry over a large portion of England and Scotland. The latter period is certainly more agreeable for the removal of furniture and other articles to a distance; but the month of November may be truly said to be the commencement of the farmer's year. By this time the labours of the harvest have been concluded, and the produce of the land secured; and he is then proceeding to prepare the ground for the crop of another season. Assuming this, then, to be the period of entry, his first crop will not be available until the termination of the first year, and we must therefore in the calculation of capital reckon all charges attending the farm during this time, deducting, of course, any sales that may be made.

I.—IMPLEMENTS.

The first calculation to be made with respect to the implements of the farm relates to the number of ploughs required, as upon this depends the number of horses to be employed. For a farm of the extent of that on which these calculations are founded, two pairs of horses will be required; the number of ploughs will accordingly be two, and that of harrows and various other implements in proportion:

2 Iron ploughs, at £4.	£8	0	0
2 Pairs of angular wooden harrows, at £1 6*s*.	2	12	0
1 Roller	6	0	0
Carried forward	£16	12	0

Brought forward	£16	12	0
1 Horse-hoe and drill-harrow	4	0	0
1 Turnip sowing machine	4	4	0
1 Bean-sower	1	10	0
1 Winnowing machine	5	0	0
4 Carts at £7	28	0	0
2 Wheel-barrows	1	10	0
1 Hand-barrow	0	4	0
1 Spade	0	2	6
1 Shovel	0	2	0
1 Set of draining tools, including spades and scoops	0	12	6
1 Mattock	0	4	0
1 Pick-axe	0	4	0
1 Foot-pick	0	7	0
1 Hammer	0	2	6
1 Sledge	0	4	0
1 Crow bar	0	6	0
1 Axe	0	3	6
2 Saws	0	4	6
3 Three-pronged dung forks	0	10	0
4 Small three-pronged forks for spreading dung and digging potatoes	0	10	0
1 Dung-drag	0	2	6
1 Mud-scraper	0	2	6
4 Long two-pronged forks for hay	0	10	0
2 Short forks for stables	0	4	0
6 Hay rakes	0	6	0
6 Turnip hoes	0	4	0
1 Turnip cutter	0	2	0
2 Hedge knives	0	5	0
1 Hedge spade	0	2	0
2 Scythes with streaks and stones	0	10	6
4 Reaping-hooks	0	4	0
1 Hay-knife	0	3	6
2 Weed-hooks	0	2	0
2 Long ladders, 24 and 18 feet	0	10	6
2 Short ladders, 12 and 8 feet	0	7	6
4 Poles for marking off ridges	0	2	0
10 Neck chains for binding cattle	0	12	6
4 Chains and neck straps for horses	0	10	0
Carried forward	£69	13	0

	£	s.	d.
Brought forward	£69	13	0
1 Pair of sheep-shears	0	3	0
1 Probang	0	15	0
1 Grindstone and frame	0	15	0
1 Weighing machine	5	5	0
2 Water buckets	0	6	0
Cart and plough harness for 4 horses	14	0	0
Ropes for 4 carts	0	12	0
Saddle-horse furniture	4	0	0
1 Corn-chest	1	0	0
3 Curry-combs	0	3	0
3 Brushes for stables	0	7	6
3 Mane-combs	0	1	6
1 Stable lantern	0	4	0
1 Hand lantern	0	2	6
1 Pair of horse-scissors	0	1	6
2 Riddles for wheat	0	5	0
2 Riddles for oats	0	4	0
1 Slap-riddle	0	1	8
1 Sieve	0	3	6
2 Barn shovels	0	4	0
1 Barn sheet	0	10	0
1 Barley hummeller	0	5	0
20 Sacks to contain 5 bushels each	2	10	0
1 bushel measure with strake	0	7	6
1 Load-barrow	0	10	0
1 Barrel of tar	0	10	0
1 Jar of oil	0	5	0
2 Stone troughs for pigs	0	15	0
Churn and other utensils of the dairy	5	5	0
Amount of Implements	£109	4	8

Thus it appears that a sum of £109 4*s.* 8*d.* will be required to procure the necessary implements for a farm of one hundred acres; and in this list such only are included as are absolutely necessary. The grubber and harrows for covering the smaller seeds are omitted, though highly essential in many cases; and a number of the smaller articles are not included in the list; for, although indispensable in the practice of farm management, they may usually be procured on the farm. The thrashing-machine is likewise omitted, being considered as a fixture of the farmery, not capable of being removed at pleasure. On a farm of the description now under consideration, the thrashing-machine will be indispensable, both for economy and convenience. The usual stock of implements of manual labour is also not included, as it is expected the workmen will supply themselves with them. When these implements belong to the farmer, it is a source of annoyance to look after them, from their being so liable to be mislaid.

II.—LIVE-STOCK.

In calculating the live-stock, it is necessary to take into consideration the quantity of land destined for their support, from which the number of each sort to be kept is to be ascertained. The number of horses has already been seen to be four, and the extent of the division in young grass necessary to produce hay and grass for soiling in the summer for them, may be estimated at six acres ; so that fourteen acres of this division, and the whole of the second year's grass, will remain for the sheep and cattle.

The sheep, it has been seen, are to be depastured on a portion of the young grass, and the peculiar circumstances of the farm alone must determine the proportion of it which is proper to be devoted to this purpose. In this calculation it may be assumed that one-half the remainder of the young grass, after supporting the horses, is to be reserved for the sheep ; the other half, or seven acres, being left to be cut for soiling for the cattle. The next object of inquiry, then, is to ascertain the number and kinds of sheep which seven acres of young grass, with an adequate supply of turnips during the winter, can maintain. It is conceived that this will be quite sufficient for a regular breeding of stock of ten Leicester ewes, which, under proper management, may be supposed to produce such a number of lambs each year, that fifteen shall arrive at maturity. These, as before explained, are to be liberally supplied with turnips during the first winter, and, after being shorn in the month of June, are to be sold to the butcher. The extent of turnips necessary for their support for six months will be about an acre, to which a quarter of an acre may be added for the ewes, so that an acre and a quarter of turnips are thus to be reckoned as the proportion required by the sheep, the remainder being reserved for the cattle.

After providing for the horses and sheep the extent of land to be appropriated to the cattle will be found to be twenty acres of grass in its second year, seven acres of young grass for soiling, and fourteen acres and three quarters in turnips, beet, and other roots. In assuming data for the calculations regarding the farm in question, it has been supposed to be in a high state of fertility, and of course, to produce abundant crops. The proportion, therefore, allotted to the support of the cattle will, it is conceived, be sufficient to maintain a breeding stock of ten cows. These will produce ten calves every year, which, according to the management before described, are to be disposed of just before completing their third year; so that there will be in every November on the farm, ten cows, ten calves, ten one year olds, and ten two year olds. To this number a bull might, perhaps, be added, but it is to be observed, that the size of the farm on which these calculations are founded is too small, to keep a bull, should his services be confined solely to the stock on the farm. But he may be kept in certain cases, with great propriety, by agreement, for serving the cows of the adjoining farms. The two year old steers, after being fed on turnips during the winter, will have completed their third year, when they are to be disposed of fat. In certain cases they might have been fat at the completion of their second year, but as this course of management is not practicable in every case, it is better to suppose them to be kept until they are three years old.

The remaining classes of live-stock, the swine and poultry, present little difficulty, as they quickly breed up the number required. The stock of swine may consist of two breeding sows and a boar; and of the poultry, a few of the different kinds will be sufficient.

Having now completed the survey of the number and kinds of live-stock, required for the farm, we are prepared for an enumeration of them, with the prices of each:

4 Work horses, at £15 each				£60	0	0
10 Leicester ewes at £2	£20	0	0			
15 Hoggets at £1	15	0	0			
1 Ram	3	0	0			
				38	0	0
Carried forward				£98	0	0

Brought forward		£98 0 0
10 Cows, short horns, or Ayrshires, at £10	£100 0 0	
10 Calves at £2 10*s.*	25 0 0	
10 One year olds at £5	50 0 0	
10 Two year olds at £9	90 0 0	
		265 0 0
2 Breeding sows at £2	4 0 0	
1 Boar	2 0 0	
		6 0 0
Poultry		2 0 0
Amount of live-stock		£371 0 0

III.—MAINTENANCE OF LIVE-STOCK, SEEDS, LABOUR, ETC.

On entering the farm, the farmer will not, of course, make advances for any portion of the crop on the land which he does not require for the maintenance of his live-stock. Such a portion of oats and hay must be procured as will be sufficient for the horses until the food to be afterwards raised is available; but with respect to the turnips and other roots, it is merely matter of convenience whether or not they are taken by the in-coming tenant, as it is optional whether the stock of cattle and sheep is purchased at the period of entry, or in the spring, when the grass is coming forward.

One of the divisions of the farm, namely, the young grass, has been sown by the out-going tenant, and, as he has derived no benefit from sowing the clover and grass seeds, it is to be expected that the in-coming tenant will repay the sum thus advanced; so that the extent of land sown with clover and grass, for which an advance is to be made the first season, will be forty acres.

The different items of expenditure may be stated as follows:

Oats for 4 horses, nine months, 260 bushels, at 2*s.* 3*d.*	£29 5 0	
Hay for six months, 6½ tons, at £3 per ton,	19 10 0	
Straw, 8 tons, at £1 10*s.*	12 0 0	
		60 15 0

Brought forward . .				£60	15	0

Although the regular stock of cattle may not be procured until the spring, two cows will be required for supplying the farmer's family with milk and butter. The sum advanced for the maintenance of them during the winter may be assumed to be:

Turnips, ¾ acre, £6	£4	10	0			
Straw, 5 tons, at £1 10*s*.	7	10	0			
				12	0	0

The sum advanced for seeds will be:

Clover and grass seeds for 40 acres, at 12*s*. 6*d*.	25	0	0			
Seed oats for 20 acres, 4½ bushels to the acre at 2*s*. 8*d*.	12	0	0			
Turnip and Beet seed, &c. for 16 acres, at 3*s*.	2	8	0			
Potatoes, 3 acres, 24 bushels to the acre, at 1*s*. 3*d*.	4	10	0			
Beans, 1 acre, 3 bushels, at 6*s*. per bushel . .	0	18	0			
Wheat for 10 acres, after potatoes, beans, and the portion of the turnip land cleared early in the season, 3 bushels to the acre, 6*s*. . .	9	0	0			
Barley for 10 acres, 3 bushels to the acre, at 3*s*. 6*d*. per bushel	5	5	0			
				59	1	0

The amount of labour, &c., may be assumed as follows:—

4 Farm labourers, 12 months, at 6*s*. per week,	£62	8	0			
Extra labour in seed-time and harvest . . .	25	0	0			
				87	8	0
Blacksmith's account for twelve months				6	0	0
Saddler's account, repairing harness, &c.				1	10	0
Carpenter's account				3	0	0
Incidental expenses of the farmery				2	10	0
Household expenses for twelve months				50	0	0
Public burdens, &c.				15	0	0
The full stock not being kept during the winter, the advance for manure may be supposed to be				50	0	0
				£347	4	0

The following abstract of expenditure will show the entire sum advanced as capital:—

1. Implements	£109	4	8
2. Live-stock	371	0	0
3. Maintenance of live-stock, seeds, labour, &c.	347	4	0
Amount of outlay . .	£827	8	8

Those parts of the produce of the farm which have been sold during the first twelve months must be taken into account. On the supposition that the full stock of cattle has not been laid in before winter, the disposable produce of the farm for the first twelve months will, however, be small. It will consist of pigs, wool, and dairy produce.

The stock of swine laid in at the period of entry will produce such a number during the season, that 20 may be sold at the end of the year; but in every succeeding year double that number may be disposed of.

20 Pigs, at £1 10*s.* each		£30	0	0
There will be 35 fleeces of wool sold the first season, namely,				
10 Ewes, at 6½lb. each	65lb.			
15 Hoggets, at 7½lb. each	112½			
Making in all	177½lb.			
177½ lb. of wool, at 1*s.* 2*d.* per pound		10	7	1
Produce of the dairy, which, besides rearing calves, may be supposed to be at the rate of 50*s.* per cow during the season		25	0	0
Amount of produce sold		£65	7	1

Amount of outlay during the first twelve months, or until the crop becomes available	827	8	8
Produce sold	65	7	1
Net capital	£762	1	7

The net amount of capital required for a farm of a hundred acres, according to this calculation, appears, therefore, to be £762 1*s.* 7*d.*, which is at the rate of £7 12*s.* 5*d.* per acre; but it is to be remembered, that, for larger farms, the amount of capital will not increase in direct proportion to the increased extent of the farm. Thus, for a farm of five hundred acres, the necessary capital will be perhaps £1 per acre less. These calculations, too, are made on the supposition that no rent is paid until the crop is available. The sum necessary for furnishing the dwelling-house is also to be added; for although the propriety of taking this item of expenditure in the estimate of the profit or loss of cultivation may be questioned, a farmer must furnish his house as well as stock his land.

It will be observed, on a review of the preceding details, that the farm, respecting which these calculations are made, is supposed to be in a high state of cultivation, being managed with especial reference to the system of agriculture described in this work, and affording the largest amount of produce. This circumstance causes the sum advanced for live-stock to be much larger than it would be under an inferior system of management; for, it is evident, that the number of animals to be fed will depend on the quantity of food which can be procured for them. There are few farms in the country that could not be stocked for a much smaller sum; but it is to be remembered, that, if the capital advanced be less, the returns will be proportionally diminished.

XXI.—EXPENSES AND PRODUCE OF THE FARM.

The expenses and produce of the farm will vary according to circumstances; and in order that a calculation may be made conveying an idea of them, it will be necessary to fix on a farm of a given extent, managed in a certain manner. In the following calculation, therefore, the same data are assumed as in calculating the capital, namely, that the farm consists of a hundred acres, and that it is managed in the manner already explained.

For the sake of convenience, the various items of expenditure on the farm had better be calculated in money. The wages of labourers, however, may, and indeed often are, paid partly in produce, and partly in money, the payment in produce being usually determined according to quantity, and not variable in price; and this system of payment is alike advantageous to both farmer and labourer. In the selection of labourers, married men are usually preferred, and in this case there should be cottages, with gardens attached, on the farm for them. When the labourer is supplied with a cottage and garden, milk, fuel, and a certain amount of farm produce, the money payment will be small.

The various kinds of outlay upon the farm may be regarded as rent, burdens, seeds, manures, labour, &c.

Rent of 100 acres of land, including tithe, at 30*s*.	£150 0 0	
Burdens, as county cess, poor rates, &c. .	15 0 0	£165 0 0
Seeds for sixteen acres of turnips, beet, &c. at 3*s*.	2 8 0	
Clover and grass seeds for 20 acres, at 12*s*. 6*d*.	12 10 0	14 18 0
Carried forward . .		£179 18 0

Brought forward				£179	18	0
It may be assumed that the whole land is limed, once during the first ten years of occupancy, at the rate of ten acres annually: 1000 bushels, at 4¼*d.*	£17	14	2			
				17	14	2
The labour and other charges, as enumerated in calculating the capital required for the farm, will be 4 farm labourers, at 6*s.* per week	62	8	0			
Extra labour in seed-time and harvest	25	0	0			
Blacksmith's account	6	0	0			
Saddler's account	1	10	0			
Carpenter's work	3	0	0			
Incidental expenses	2	10	0			
				100	8	0
Amount of expenditure				£298	0	2

There now remains to be considered, what, on this calculation, may be the annual return of such a farm. This will include the vegetable produce and the live stock.

20 acres of oats, at 55 bushels per acre		1100 bushels.
The quantity consumed on the farm is		
For seed	90	
For horses	260	
For hogs, poultry, &c.	10	
		360 bushels.
Leaves to be disposed of		740 bushels.
10 acres of wheat, at 35 bushels per acre		350 bushels.
Deduct for seed, at 3 bushels per acre		30
Leaves to be disposed of		320 bushels.
10 acres of barley, at 40 bushels per acre		400 bushels.
Deduct for seed, at 3 bushels per acre		30
Leaves to be disposed of		370 bushels.

The amount of vegetable produce of the farm will, therefore, stand thus:

740 bushels of oats, at 2*s.* 6*d.* per bushel	£92	10	0
320 bushels of wheat, at 5*s.* 8*d.* per bushel	96	0	0
370 bushels of barley, at 3*s.* 6*d.* per bushel	64	15	0
Carried forward	£253	5	0

Brought forward . . £253 5 0

The return from the live-stock of the farm will be as follows:

The produce of the dairy, after rearing 10 calves, may be calculated at £2 10*s.* per cow . .	£25	0	0			
40 Pigs may be supposed to be sold at £1 . .	40	0	0			
10 Three-year-old steers, at £17 each . . .	170	0	0			
15 Two-year-old sheep, at £1 10*s.*	22	10	0			
Wool of 10 ewes and 15 hoggets, 177½lbs., at 1*s.* 2*d.*	10	7	1			
				272	17	1
				526	2	1

From the gross produce thus obtained, ...	526	2	1
Deduct the expenditure in money, ...	298	0	2
And the net return to the farmer will be, ...	£228	1	11

In the preceding calculations of capital, and expenses and produce, it has been assumed that the farm in question is in a high state of cultivation, and consequently affording a large return of produce. No allowance, is, therefore, made for outlay in improvements, as fencing, draining, building, or other items of expenditure, not necessarily connected with the cultivation of the land; though improvements of the kind will be constantly going forward to a greater or less extent, in almost every situation. In calculating the nett amount of profit produced by farming, it will, therefore, be necessary to take such items of expenditure into account, as they will be so much of a direct tax on the farmer's profit. Although we have no doubt that the preceding returns will be made in cases analogous to the data assumed ; yet, taking the general circumstances of the country, as regarding soil and situation, into consideration, one half of the return in question may be regarded as nearer the actual average produce. The system of cultivation must also be economical, and the production of grain be regarded as subsidiary to the rearing and feeding of live stock. In the management of cattle, too, the soiling system must be carried into operation so far as the circumstances of the farm will admit.

In the present state of our knowledge of the productive powers of the soil, we can scarcely form an idea of what may yet be effected in increasing its fertility. Defective as our system of cultivation assuredly is, in many respects, the produce of the land has been more than doubled within the last half century; and when this has been accomplished without any great departure from the system of our ancestors, the most cheering results may be anticipated from the great, and almost universal attention now directed to agricultural improvement.

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